POLICY RESEARCH WORKING PAPER 1783

Trade Policy Options for Chile

A Quantitative Evaluation

Glenn W. Harrison
Thomas F. Rutherford
David G. Tarr

Welfare in Chile would be improved by moving toward uniformity in the value-added tax and lowering the Chilean tariff to between 6 and 8 percent.

The World Bank
International Economics Department
International Trade Division
June 1997

Summary findings

Chile is currently evaluating a wide range of possible trade policies. Using a global computable general equilibrium model, Harrison, Rutherford, and Tarr examine a range of trade policy and complementary tax policy options for Chile.

They focus on Chile's principal preferential trade policy options: a free-trade area with MERCOSUR, a customs union with MERCOSUR, and a free trade area with NAFTA. They also examine such options as complementary tariff reduction with nonpartner countries in combination with implementing the free trade area options; unilateral or global trade liberalization; and the optimum unilateral tariff.

Their principal policy conclusions:

- Lowering Chile's tariffs preferentially or multilaterally leads to only small gains as Chile starts with a rather efficient external trade regime, uniform tariffs of 11 percent.
- Largely because of its efficient uniform tariff, preferential tariff reduction will reduce Chilean welfare through trade diversion, unless Chile can improve its access in the markets of partner countries.
- NAFTA offers enough access to benefit Chile; MERCOSUR does not, once the trade diversion costs of MERCOSUR are taken into account.
- Under their preferred-elasticity scenario, Chile can convert the MERCOSUR agreement from a loss to a gain if it lowers its external tariff to between 6 and 8 percent. Doing so will also increase the gains from a potential agreement with NAFTA.
- Chile's current value-added tax imposes distortionary costs because collection rates are not uniform. Chile will gain if it can collect the VAT more uniformly.
- Tariff reductions from trade reform will require an increase in domestic taxes, so greater uniformity in domestic taxes (less distortion in replacement taxes) will maximize the benefits from trade reform. Welfare will be improved by moving toward uniformity in the VAT and lowering the Chilean tariff to between 6 and 8 percent.

This model ignores dynamic gains from trade liberalization, the result of importing either a greater variety of products or more technologically advanced products.

This paper — a product of the International Trade Division, International Economics Department — is part of a larger effort in the department to examine the impact of regional trade integration in developing countries. Copies of the paper are available free from the World Bank, 1818 H Street NW, Washington, DC 20433. Please contact Jennifer Ngaine, room N5-060, telephone 202-473-7947, fax 202-522-1159, Internet address trade@worldbank.org. June 1997. (76 pages)

Trade Policy Options for Chile:

A Quantitative Evaluation

by

Glenn W. Harrison, Thomas F. Rutherford and David G. Tarr†

† Harrison is Dewey H. Johnson Professor of Economics, Department of Economics, College of Business Administration, University of South Carolina, Columbia, SC 29208, USA (E-mail: HARRISON@DARLA.BADM.SC.EDU; Fax: (803) 749-8924). Rutherford is Assistant Professor, Department of Economics, University of Colorado, Boulder, CO 80303, USA (E-mail: RUTHERFORD@COLORADO.EDU; Fax: (303) 492-5169). Tarr is Lead Economist, International Trade Division, World Bank, 1818 H. Street NW, Washington DC 20006 (E-mail: DTARR@WORLDBANK.ORG; Fax: (202) 522-1159). We would like to acknowledge the helpful comments of: Jerry Haar of the North-South Center; Maurice Schiff, Alberto Valdes and L. Alan Winters of the World Bank; Dominique Hachette, Juan Coeymans and other seminar participants at Pontifica Universidad Catolica de Chile; Eugenia Muchnik and Hector Assael of the U.N. Economic Commission for Latin America in Santiago; Maria Wagner of the Chilean Ministry of Finance; M. Marcel of the Chilean Treasury; Klaus Schmidt-Hebbel, Ricardo Vicuña and seminar participants at the Central Bank of Chile; and Liselott Kana of the Chilean Ministry of Foreign Affairs. We thank Isidro Soloaga, Ulrich Reincke and Minerva Pateña for excellent research, translation and logistical support. We are grateful to the North-South Center for research support. The views expressed are those of the authors *not* necessarily those of the World Bank or any of its Executive Directors, the North-South Center, any agency of the government of Chile or those acknowledged.

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Summary of principal policy conclusions:

1. Since Chile starts with a rather efficient external trade regime of 11% uniform tariffs, our results show that lowering its tariffs preferentially or multilaterally leads to only small gains.

2. Preferential tariff reduction will reduce Chilean welfare due to trade diversion unless significantly improved access can be obtained in the markets of partner countries. We show this is due in large part to the efficient uniform tariff that Chile starts with.

3. We find that the NAFTA option offers sufficient access to benefit Chile, but MERCOSUR does not. That is, the trade diversion costs of MERCOSUR dominate the welfare effects for Chile even when improved access to MERCOSUR markets is incorporated.

4. In our preferred elasticity scenario, Chile can convert the MERCOSUR agreement from a loss to a gain if it lowers its external tariff to between 6 and 8 percent. Lowering the external tariff to between 6 and 8 percent will also increase the gains from a potential agreement with NAFTA.

5. The existing Value Added Tax in Chile imposes distortionary costs due to non-uniform collection rates. Moving toward collecting the Value Added Tax at a uniform rate will reduce distortions and provide substantial benefits.

6. Since tariff reductions from trade reform will require an increase in domestic taxes, greater uniformity in the domestic tax structure (that is, less distortion costs from replacement taxes) will increase the benefits of trade reform. If combined with a movement toward uniformity of the VAT, unilateral and multilateral lowering of the Chilean tariff to between 6 and 8 percent will increase Chilean welfare in our preferred central elasticity case.

7. Our model ignores dynamic gains from trade liberalization, which could arise from importing either technologically advanced products or a greater variety of products. Then either multilateral trade liberalization or preferential arrangements with a large technologically advanced region could lead to much larger gains than we have estimated.

Foreword

As regional trading arrangements (RTAs) have spread, enlarged and deepened over the last decade, they have posed challenges to economists on both intellectual and policy levels. On the former, do RTAs stimulate growth and investment, facilitate technology transfer, shift comparative advantage towards high value-added activities, provide credibility to reform programs, or induce political stability and cooperation? Or do they, on the other hand, divert trade in inefficient directions and undermine the multilateral trading system?

The answer is probably "all of these things, in different proportions according to the particular circumstances of each RTA." This then poses the policy challenge of how best to manage RTAs in order to get the best balance of benefits and costs. For example, should technical standards be harmonized and, if so, how; do direct or indirect taxes need to be equalized; how should RTAs manage their international trade policies in an outward-looking fashion?

Addressing these issues is one important focus of the research program of the International Trade Division of the World Bank. It has produced a number of methodological innovations in the traditional area of trade effects of RTAs and tackled four new areas of research: the dynamics of regionalism (e.g., convergence, growth, investment, industrial location and migration), deep integration (standards, tax harmonization), regionalism and the rest of the world (including its effects on the multilateral trading system), and certain political economy dimensions of regionalism (e.g., credibility and the use of RTAs as tools of diplomacy).

In addition to thematic work, the program includes a number of studies of specific regional arrangements, conducted in collaboration with the Regional Vice Presidencies of the Bank. Several EU-Mediterranean Association Agreements have been studied and a joint program with the staff of the Latin American and Caribbean Region entitled "**Making the Most of Mercosur**" is under way. Future work is planned on African and Asian regional integration schemes.

Regionalism and Development findings have been and will, in future, be released in a number of outlets. Recent World Bank Policy Research Working Papers concerning these issues include:

Glenn Harrison, Tom Rutherford and David Tarr, "Economic Implications for Turkey of a Customs Union with the European Union," (WPS 1599, May 1996).

Maurice Schiff, "Small is Beautiful, Preferential Trade Agreements and the Impact of Country Size, Market Share, Efficiency and Trade Policy," (WPS 1668, October 1996).

L. Alan Winters, "Regionalism versus Multilateralism," (WPS 1687, November 1996).

Magnus Blomström and Ari Kokko, "How Foreign Investment Affects Host Countries" (WPS1745, March 1997)

Eric Bond, "Using Tariff Indices to Evaluate Preferential Trading Arrangements: An Application to Chile" (WPS1751, April 1997)

Magnus Blomström and Ari Kokko, "Regional Integration and Foreign Direct Investment: A Conceptual Framework and Three Cases" (WPS1750, April 1997)

Planned future issues in this series include:

Pier Carlo Padoan, "Technology Accumulation and Diffusion: Is There a Regional Dimension?"

Sherry Stephenson, "Standards, Conformity Assessments and Developing Countries"

Maurice Schiff and L. Alan Winters, "Regional Integration as Diplomacy"

Anthony Venables and Diego Puga, "Trading Arrangements and Industrial Development" (forthcoming)

Other papers on regionalism produced by IECIT include:

Ahmed Galal and Bernard Hoekman (eds), Regional Partners in Global Markets: Limits and Possibilities of the Euro-Med Initiative. CEPR 1997.

Bernard Hoekman and Simeon Djankov, "Imports of Inputs, Foreign Investment and Reorientation of East European Trade," World Bank Economic Review (forthcoming)

Bernard Hoekman and Simeon Djankov, "The EU's Mediterranean Free Trade Initiative," World Economy

Bernard Hoekman and Simeon Djankov, "Effective Protection in Jordan and Egypt in the Transition to Free Trade with Europe," World Development.

Bartlomiej Kaminski, "Establishing Economic Foundations for a Viable State of Bosnia and Hercegovina: Issues and Policies".

In addition, **Making the Most of Mercosur** issued the following papers:

Alexander J. Yeats, "Does Mercosur's Trade Performance Raise Concerns About the Effects of Regional Trade Arrangements?" (WPS1729, February 1997))

Azita Amjadi and L. Alan Winters, "Transport Costs and 'Natural' Integration in Mercosur" (WPS1742, March 1997)

Claudio Frischtak, Danny M. Leipziger and John F. Normand, "Industrial Policy in Mercosur: Issues and Lessons"

Sam Laird (WTO), "Mercosur Trade Policy: Towards Greater Integration"

Margaret Miller and Jerry Caprio, "Empirical Evidence on the Role of Credit for SME Exports in Mercosur"

Malcom Rowat, "Competition Policy within Mercosur"

For copies of these papers or information about these programs contact Maurice Schiff, The World Bank, 1818 H Street NW, Washington, D.C. 20433.

An additional major outlet for World Bank-sponsored research on regionalism will be the Annual Bank Conference on Development in Latin America, 1997, Montevideo, June 30-July 2, 1997, organized by the Office of the Chief Economist and the Technical Department for Latin America and the Caribbean Region, with the support of the International Trade Division and the Economic Development Institute.

Masood Ahmed
Director
International Economics Department

Trade Policy Options for Chile:

A Quantitative Evaluation

by Glenn W. Harrison, Thomas F. Rutherford and David G. Tarr*

1. Introduction and Summary of Results

Chile is currently evaluating a wide range of possible trade policies. We employ a global computable general equilibrium model to quantitatively examine a broad range of trade policy and complementary tax policy options for Chile. We begin with and focus on Chile's principal preferential trade policy options: (1) a free trade area with MERCOSUR[1]; (2) a customs union with MERCOSUR; and (3) a free trade area with NAFTA. We also evaluate other trade policy options for Chile, including an evaluation of complementary tariff reduction with non-partner countries in

*We would like to acknowledge the helpful comments of: Jerry Haar of the North-South Center; Maurice Schiff, Alberto Valdes and L. Alan Winters of the World Bank; Dominique Hachette, Juan Coeymans and other seminar participants at Pontifica Universidad Catolica de Chile; Eugenia Muchnik and Hector Assael of the U.N. Economic Commission for Latin America in Santiago; Maria Wagner of the Chilean Ministry of Finance; M. Marcel of the Chilean Treasury; Klaus Schmidt-Hebbel, Ricardo Vicuña and seminar participants at the Central Bank of Chile; and Liselott Kana of the Chilean Ministry of Foreign Affairs. We thank Isidro Soloaga, Ulrich Reincke and Minerva Pateña for excellent research, translation and logistical support. We are grateful to the North-South Center for research support. The views expressed are those of the authors *not* necessarily those of the World Bank or any of its Executive Directors, the North-South Center, any agency of the government of Chile or those acknowledged.

[1]MERCOSUR is a customs union between Argentina, Brazil, Paraguay and Uruguay. In a free trade area Chile and the partner area eliminate tariffs and export taxes or subsidies against each other, but retain separate tariffs against third countries. In a customs union Chile and the partner region adopt a common external tariff. The free trade area between Chile and MERCOSUR has been agreed; a customs union with MERCOSUR is a possibility, although remote. Recent events in Mexico and domestic political considerations in the United States have stalled negotiations for Chile's membership of NAFTA. Nonetheless, many commentators believe that this option is still viable in the medium run. Again, the proposal is for Chile to join NAFTA as a free trade area and to retain its tariffs on third countries.

combination with implementation of the free trade area options; unilateral or global trade liberalization; and the optimum unilateral tariff. In all cases, we examine the role of domestic taxes to compensate for the revenue loss, and show how the choice of these taxes is important to effective implementation of the trade policies. Our welfare and tax implication results are summarized in Table 1.

Several features of the Chilean economy drive our results. Contrary to many other countries implementing preferential trade agreements, Chile starts with a relatively liberal external trade regime since it has a low uniform tariff of 11%. That is, Chile's external trade regime generates few distortions compared with many other countries. Thus, although marginal improvements can be achieved, Chile can do little to greatly improve the efficiency of its resource allocation while relying simply on further reduction of its tariffs.[2]

Despite Chile's small share in export markets, it may have a small amount of monopoly power in export markets. From Lerner symmetry effects, Chile's uniform import tariff is equivalent to an export tax, and thus can serve the role of exploiting any market power on exports Chile may possess. With central elasticities that market power will be very small, and hence the optimal Chilean export tariff will be very small (about 3-4 percent in our model with central elasticities). However, with low elasticities the optimal export tariff to exploit market power will be higher (about 14 percent).[3] Since Chile starts with an 11 percent uniform tariff, reductions at the margin from this tariff will increase welfare in our central elasticity scenario but reduce welfare in our low

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[2]This conclusion ignores dynamic gains from trade liberalization, which could lead to much larger gains.

[3]For all regions the elasticity of substitution in demand between imports from different countries is 30 with central elasticities and 8 with low elasticities. This is the key parameter determining the extent of Chilean monopoly power in our model.

elasticity scenario. Since we believe that Chile has little monopoly power on world markets, we prefer to focus on the central elasticity scenarios in Table 1. We present a full set of results for lower elasticities, however, since there are some who believe that trade elasticities are lower, and presentation of the different elasticity dependent estimates provides insight into the relationship between terms-of-trade effects and elasticities. In addition, we also present some results from an alternate high elasticity model formulation in which Chile has virtually no monopoly power.

We systematically evaluate the interaction between domestic taxes and trade policy. Our results indicate that the gains can be considerably increased if trade policy reform is accompanied by domestic tax reform, and that the gains from domestic tax reform are substantial in their own right. Thus, in Table 1 the trade policy options are evaluated under a variety of replacement tax options. That is, the trade policy options will result in a reduction in government revenues, but we impose the constraint in our model that lost government revenues are replaced by the VAT. In an appendix Isidro Soloaga provides an updated estimate of the collected VAT rates by sector in Chile. Although the legal rate of VAT is 18% for all sectors, collection of the existing VAT is non-uniform and it thus imposes distortion costs. Use of the existing VAT therefore limits the scope for welfare increasing tariff reduction, either multilaterally or preferentially. We show that Chile can reduce its legal VAT rates to about 50% of present levels and improve its welfare by 0.3% of its GDP if it were able to eliminate evasion and collect the VAT uniformly.[4] These gains are substantial and comparable to the best trade policy options. Moreover, the beneficial trade policy options generate considerably more gains if a uniform VAT is achieved.

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[4]In addition, we eliminate the output tax, which applies primarily to energy and beverages and tobacco.

Now consider our estimates in Table 1 beginning with the preferential trade arrangements. With central elasticities, either the free trade area or a customs union with MERCOSUR will be significantly welfare reducing for Chile (welfare losses would be between 0.4 and 0.9 percent of Chilean GDP per year) and would require large compensating increases in the VAT (rows 1 and 2 of Table 1). If demand elasticities are low, there is much less trade diversion, and these arrangements can be marginally welfare improving, but the welfare effect is close to zero. These calculations take into account the value to Chile of improved terms-of-trade (access) in the markets of MERCOSUR. In section 2 we provide a detailed, graphical explanation of the welfare economics of preferential trade arrangements to provide further intuition for these results.

On the other hand, we estimate that the free trade area with NAFTA will increase Chilean welfare under virtually all of our elasticity and replacement tax scenarios. The main reason for the gains in the case of NAFTA is the value to Chile of improved access to the NAFTA market. If Chile were to preferentially lower its tariffs to zero against all NAFTA countries without receiving improved access to the NAFTA market, Chile would lose significantly from NAFTA. In fact, even if lack of improved access were limited to only one sector in our model, non-grain crops, Chile would lose from NAFTA. This result provides a concrete example of the point emphasized by Wonnacott and Wonnacott [1981] regarding the importance of improved access in preferential trading areas. Thus, we find *welfare gains from any of the preferential trade arrangement under active consideration only if it obtains significantly improved access, and only NAFTA provides sufficient access.*

We also show that the fact that Chile starts with a uniform tariff partly explains its lack of benefits from preferential tariff reduction. The preferential trading arrangement introduces some

non-uniformity into the otherwise uniform Chilean trade regime, which typically reduces the benefits in our model.

We have examined the impact of lowering the tariff to 6% and also implementing the preferential trade arrangements (rows 5 and 6 of Table 1). Reducing tariffs to 6% will reduce the trade diversion costs and improve welfare to that extent. Comparing row 5 with row 1 and row 6 with row 3, we see that with our preferred central elasticities welfare is significantly improved. With low elasticities, however, there is an adverse terms-of-trade effect that mitigates the welfare gains from reduced costs of trade diversion.

In rows 7, 8 and 9 we show the welfare effects to Chile of multilateral trade liberalization. With our central elasticities and use of a distortionless domestic tax replacement, Chile will gain from reducing the tariff to 6 %. In column 3 we see there are additional marginal gains from reducing the external tariff from 8 % to 6%. In column 1, however, one can see that if the existing VAT is employed, however, the marginal multilateral reduction in tariffs from 8% to 6% reduces welfare, since the domestic tax distortions limit the scope for trade policy. However, even with a distortionless tax, a reduction to zero is immiserizing due to adverse terms-of-trade effects with our central elasticities. Of course, higher elasticities would yield lower optimal tariffs.

Our quantitative model of the Chilean economy also explicitly includes the economies of Argentina, Brazil, Mexico, the United States, Canada, the European Union and several other countries or regions that Chile trades with. Since the results of preferential trade arrangements are ambiguous in general, the objective of using a CGE model is to determine the relative impact of various effects and to quantitatively assess what are the most important policy reforms available for Chile.

The model which we use is an extended and updated version of a model which we developed recently to study the effects of the Uruguay Round. The model specification has been documented in detail in Harrison, Rutherford and Tarr [1995] [1995a] [forthcoming]. The model is updated with a new data base that reflects more recent information on production structures and trade policies in most of the countries included. It has also been extended to include several new countries, most notably to include an explicit representation of Chile. It allows us to incorporate the "market access" effects of partner country tariff reductions on Chile, as well as the traditional effects of tariff reform in Chile itself.

In Section 2 we provide a graphical description of the welfare economics of preferential trade agreements which should facilitate greater intuition into our results. In Section 3 we briefly describe the model. In Section 4 we describe the policy results obtained with this model, and explain intuitively what is driving these results.

2. The Welfare Economics of Preferential Trade Agreements

A graphical exposition of the welfare economics of preferential trade arrangements, which is based on a similar presentation in Bhagwati and Panagariya [1996], will help explain the numerical results we obtain in the next section. Apart from the partial equilibrium nature of the diagram, it represents accurately the type of model structure we employ. To be consistent with the data that shows both imports and exports of the same product group at a fairly disaggregated level, we assume in Figure 1 that goods are differentiated by country of origin (the Armington assumption). The home country's demand for a representative good from the partner country is

measured to the right of the origin and its demand for the similar, but not identical, good from the rest of the world is measured to the left of the origin. We choose units so that the world price of both the partner good and the good from the rest of the world is unity in the initial equilibrium. We assume that the preferential trade area is not yet implemented in the initial equilibrium, so that the *ad valorem* tariff rate t applies to imports from both sources.

Consider a small preferential reduction in the tariff on partner country imports to t′. This results in an increase in the quantity demanded for partner country imports to P′. Since imports from the rest of the world are gross substitutes with partner country imports, there is a downward shift in demand for imports from the rest of the world to M'_R. In the new equilibrium the quantity demanded of imports from the rest of the world declines to R′.

The welfare calculation proceeds in the standard manner. In the market for partner country imports, consumer surplus increases by the area B + A. The net change in tariff revenue is T_P - B, yielding a "trade creation" area of A + T_P in the market for partner country imports. In the market for imports from the rest of the world, there is a loss of "surplus" equal to the lost tariff revenue (the "trade diversion" effect), which is the area T_R. Following the principles developed by Harberger [1971], this is a loss in welfare to the home country,[5] and we ignore the market for the home

[5]The justification for the welfare analysis of Figure 1 is equation 8 (or its special case, equation 5) in Harberger [1971]. He considers the case where there is a change in the tax on good 1 (in our case lowering the tariff against partner country imports) in the presence of taxes on other goods in the economy, say goods 2, ..., n. In our case, the most notable other tax is the tariff on competing imports from the rest of the world in the same sector. Then the change in welfare is the change in surplus on good 1, plus the change in surplus on goods 2 through n, where the latter is equal to the tax in the other sectors times the change in quantity in those sectors, summed over all such sectors. To simplify Figure 1, and because the cross-substitution effect in demand will be smaller and of either sign in the other sectors, we have ignored sectors outside of the directly competing import sector. Our quantitative analysis, which is general equilibrium and based on the Hicksian equivalent variation, incorporates the welfare changes from *all* goods.

country's good, since there is no difference between price and marginal cost in the market for the home country's product. Thus, the net change in welfare is equal to $A + T_P - T_R$.

Is there a net gain or loss to the home country from this change? The answer depends on the relative size of the two shaded areas in Figure 1. For a very small change in the initial tariff rate toward the partner country, these areas are approximated by rectangles whose height is the initial tariff rate. Then there is a net gain or loss to the home country if and only if the base of the rectangle T_P is larger than the base of the rectangle T_R, which occurs if the increase in imports from the partner country exceeds the decline in imports from the rest of the world. With a decline in the price of imports from the partner country, aggregate imports have become relatively cheap compared to home country production. Since imports will also typically be gross substitutes for home country production, consumers will increase their demand for aggregate imports at the expenses of domestic production. Then there will be an increase in the total demand for imports due to a substitution away from domestic production, and an increase in exports to satisfy the trade balance condition. Thus, for a small preferential reduction in the tariff, there *must* be an increase in the net welfare of the home country.

Now consider progressive preferential reduction of the tariff on the partner country. For each successive reduction of the tariff on the partner country, the height of the trade creation area declines but the height of the trade diversion rectangle for imports from the rest of the world does not. At some point, before the tariff on partner country imports goes to zero, further preferential tariff reduction will reduce welfare.

Summarizing, some small preferential tariff reduction is beneficial, but eventually it becomes harmful. Thus, in general we do not know from economic theory if trade creation or trade diversion

dominates the welfare economics of complete tariff elimination against partner country imports. The actual outcome will depend on economic variables specific to the country such as elasticities, tariffs and shares. We can, however, use Figure 1 to derive a number of insights on how the parameters affect the results.

First, if the tariff on imports from the rest of the world is lowered, the rectangle of trade diversion will be smaller. In the limit, the home country can eliminate trade diversion completely by going to free trade on imports from the rest of the world. This has important policy implications for a country participating in a free trade area, since it can always lower its tariff on imports from the rest of the world sufficiently to generate gains from the Free trade area. We show below that if Chile were to lower its tariff on the rest of the world to 6%, it will increase the gains (or reduce the losses) of any free trade agreement in which it would participate. One disadvantage of a customs union over a free trade area is that Chile gives up its ability to reduce its tariffs on the rest of the world.

A second insight from Figure 1 is that if products from the partner country and the rest of the world are very good substitutes the trade diversion rectangle will be relatively large. That is, if the cross elasticity of demand between partner country imports and rest of the world imports is larger (σ_{MM} in our model), the rectangle of trade diversion will be larger. Intuitively, when partner country products can replace imports from the rest of the world easily there will be greater displacement of partner country imports and greater tariff loss. It is for this reason that our estimates of the gains from regional trade arrangements decrease as we increase the assumed trade elasticities.

Finally, if home country products and imports are good substitutes (σ_{DM} in our model), it is more likely that preferential trade arrangements will be beneficial. That is, if home country products

and imports are good substitutes then the demand curves in Figure 1 will be relatively flat and the area $A + T_P$ will be larger. Intuitively, if imports from the partner country can substitute easily for home country products, the amount of trade creation will be greater following a reduction of tariffs to the partner country.

One important element that is missing from Figure 1 is the value to the home country of improved access to the markets of the partner country. An agreement which would be immiserizing without improved access *could* improve welfare when improved access is taken into account. We show below that this in fact occurs with respect to the welfare impact of Chile joining NAFTA. This point has been stressed by Wonnacott and Wonnacott [1981], who argue that many analyses of the effects of a customs union or free trade area ignore the benefits of improved market access. The policy implications of this omission are quite simple: if market access is ignored or assumed to be negligible, then there is nothing that a small open economy such as Chile can achieve from signing preferential trade agreements that it cannot achieve by unilateral policy actions.[6]

3. A Multi-Regional Trade Model

A. General Features of our Model

The quantitative model developed to evaluate the trade policy options facing Chile is multi-regional and multi-sectoral. Table 2 lists the 11 regions included explicitly in the model, as well as the 24 sectors included in each region. The general specification of this model follows our earlier

[6]This conclusion needs to be qualified, since we assume constant returns to scale and perfect competition in our model. Models with imperfect competition which yield additional benefits from more or better varieties of imports could introduce gains from preferential trade arrangements if the arrangement is with a technologically advanced region.

multi-regional model of the effects of the Uruguay Round. The most important differences are the inclusion of data for Chile, updated tariff rates for Argentina and Brazil, as well as more recent data for all other regions.

Why adopt a model that includes so many regions, when our interest is in evaluating the effects on Chile of the proposed reforms? The answer is that the proposed reforms entail changes in trade policies for Chile and trading partners of Chile. In the case of membership of MERCOSUR, for example, we need to consider the effects on Chile of a reduction in Chile's import tariffs on other MERCOSUR members. We also need to account for the "market access" effects on Chile of a reduction of import tariffs by MERCOSUR or NAFTA members on Chile's exports to them. Although we could account for these changes exogenously by changing the terms-of-trade of Chile in a somewhat *ad hoc* manner in a small open economy model, these impacts are best assessed endogenously.

Although the general theory of the effects of preferential trading arrangements does allow for these changes in partner country tariffs on the home country,[7] some empirical approaches to evaluating these effects ignore them.[8] As mentioned above, this important policy issue has been stressed by Wonnacott and Wonnacott [1981]. Our framework allows us to explicitly evaluate the importance to Chile of improved market access to MERCOSUR and NAFTA.

The sectoral detail in our model gives a rich picture of the economic structure of Chile's

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[7] See Wooton [1986], and Harrison, Rutherford and Wooton [1989] [1993].

[8] An example is the approach adopted by Bond [1996]. He develops a simple general equilibrium specification of the effects on Chile of these preferential trading arrangements with an impressive level of detail with respect to tariff data. His results for Chile joining NAFTA, however, differ from ours, since his CGE model does not allow changes in the price of exports or imports. Thus, it does not incorporate the impact of the terms-of-trade gain to Chile of access to NAFTA markets.

domestic production and trade. Table 3 provides a summary of economic activity in Chile. The first two columns show value added in millions of U.S. dollars and then as a percentage of aggregate value added, respectively. In terms of production structure we see that Chile is a relatively evolved country with 61% of its value added generated by the trade and transport sectors and service sectors. The next column shows the labor share of value added in each sector in percentage form, which is an indicator of relative labor intensity in each sector.

The next two columns indicate the total value of exports and the share of aggregate exports generated by each sector. Copper exports show up in two sectors, the mineral products sector and, most prominently, in the non-ferrous metals sector. In addition we see that exports of non-grain crops and food products are significant as a percent of aggregate exports. The final two columns provide comparable data for Chile's imports in value terms and percentage terms. Imports tend to be concentrated in capital intensive industries such as machinery and equipment, transport industries, chemicals and rubber and plastics, and textiles and apparel and leather products. There are also significant imports of energy, reflected in the energy products sector.

In Table 4 we examine the trade flows for Chile in more detail. The first column shows exports in each sector as a fraction of domestic output and the second column shows imports in each sector as a fraction of domestic demand, each as a percentage. We see that exports are particularly important in non-ferrous metals and the small transportation and iron and steel sectors.

The third column in Table 4 shows the import-weighted tariff rate which is a constant 11% across all traded sectors. This reflects the uniform legal tariff rate applied in Chile.[9] The model also

[9]Chile applies a variable levy system on imports of wheat, sugar and edible oils. Monthly prices over the previous two years are examined and the distribution is truncated at the top and the bottom by

includes some small export taxes on select commodities shown in the fourth column of Table 4. The last three columns of Table 4 show export weighted average tariffs on Chile's exports. These are import tariffs by other countries on imports from Chile to them. The column TXT_AVE percent shows an export weighted average tariff across all countries to which Chile currently exports.

The next two columns show the average tariffs applied on Chile's exports to Brazil and the United States, respectively. These are important indicators of the tariff reductions which Chile will benefit from when it joins MERCOSUR or NAFTA, respectively. Consider first the tariffs which Brazil applies on Chilean imports, noting also that the tariffs which Argentina applies on Chile's imports are virtually identical. It is interesting to note that in many manufacturing sectors these tariffs are significantly higher than those that Chile currently applies on a nondiscriminatory basis. This means that Chile's adoption of the common external tariff of MERCOSUR, to the extent that it is reflected in the rates which are shown for Brazil, will entail Chile adopting a *more* protectionist tariff structure against third countries than it currently has. Another implications of these rates being so high is that Chile will benefit tremendously from their reduction to zero once it joins MERCOSUR. Similarly the import tariff rates for the United States on Chilean exports to the United States are, in many sectors, very high.

In terms of Chile's exports, and only looking at the items that are large in absolute size, we see that the United States is a relatively important trading partner. The United States is the destination of 29% of Chile's exports of non-grain crops, 10% of its exports of food products, 12%

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an equal percentage (about 15%). The range of the resulting truncated distribution determines the upper and lower bounds. A tariff surcharge or reduction of the tariff below the 11% rate is applied if the price in the present month is below or above the bounds. Since the system is not based on a domestic support price, in practice it has had only a small impact on protection (equal to about 2-3 percent of additional tariff protection) which we ignore in the analysis. See Quiroz and Valdes [1993] and Valdes [1996].

of its exports of lumber and wood, and 16% of its exports of non-ferrous metals. The other members of NAFTA, Canada and Mexico, are not particularly important trading partners with Chile. Brazil and Argentina are significant export destinations for some of Chile's significant exports. Brazil buys 10% of the Chile's exports of mining products. Argentina and Brazil jointly purchase 7% of the Chilean exports of food, 15% of pulp and paper products, 8% of the exports of non-ferrous metals, and 15% of the exports of trade and transport services.

Turning to imports of Chile we see that the United States is even more important than it is with respect to Chile's exports. From the United States, Chile imports 18% of its textile products, 31% of its chemical and rubber and plastic products, 27% of its transportation equipment, 31% of its machinery and equipment, and 30% of its imported services. Argentina sells Chile 10% of Chile's imports of energy products and 10% of its services imports. Brazil supplies 14% of Chile's imports of transportation equipment.

In Table 5 we also provide details on domestic distortions in Chile. The first column, VAT, represents a tax on value added in each industry. The second column, TY, represents a tax on gross output. These rates were estimated using procedures explained in the appendix./

B. Formal Specification

The general specification of the model follows our earlier work on the Uruguay Round (see Harrison, Rutherford and Tarr [1995] [1996a] [1997, forthcoming]. We concentrate here on what we have called our "base" model, which is static and assumes constant returns to scale (CRTS). Except for the fact that imports and exports are distinguished by many regions, the structure of the model within any country is very close to that of the basic model of de Melo and Tarr [1992]; the

interested reader may consult their chapter 3 for a detailed explanation of the equations.

Except for tariff data and the domestic tax data, the data employed to calibrate the model come primarily from the GTAP database documented in Gehlhar et al. [1996]. We use the preliminary release of version 3 of this database, current as of May 1996. The 11–region version of the model retains all the regions of the GTAP database that are directly relevant to our policy simulations. The sectors were selected such that those in which significant reduction in distortions occurred are retained as individual sectors. This should minimize aggregation bias.

In appendix C we formally characterize the demand structure and elasticities which are critical to the results. Demand is characterized by nested Constant Elasticity of Substitution (CES) utility functions for each agent, which allow multi-stage budgeting. Demand at the top level, for the composite "Armington" aggregate of each of the 24 goods in Table 1, is Cobb-Douglas. Consumers first choose how much of each Armington aggregate good to consume, like wheat, subject to aggregate incomes and composite prices of the aggregate goods. The Armington aggregate good is in turn a CES composite of domestic production and aggregate imports. Consumers decide how much to spend on aggregate imports and the domestic good subject to the prior decision of how much income will be spent on this sector and preferences for aggregate imports and domestic goods reflected by the CES utility function. Finally, consumers decide how to allocate expenditures across imports from the 10 other regions based on their CES utility function for imports from different regions and income allocated to consumption on imports from the previous higher level decision.

Relying on our *a priori* beliefs as to plausible values for these elasticities, we generally assume that the lower-level elasticity of substitution between imports from different regions σ_{MM} is 30 and the higher-level elasticity between aggregate imports and domestic production σ_{DM} is 15. We

refer to these values as our central elasticities. Although the majority of econometric studies suggest values which are lower than these (see Reinert and Roland-Holst [1992] and Shiells and Reinert [1993]), the studies by Reidel [1988] and Athukorala and Reidel [1994] argue that when the model is properly specified, the elasticities are not statistically different from infinite and their point estimates are close to the central elasticity values we have chosen. Moreover, elasticities would be expected to increase over time, and this model presumes an adjustment of about 10 years, a rather long period in the context of these econometric estimates.

Another reason we adopt these elasticities as our preferred values is that low values of these elasticities will imply that small open economies have significant market power on world markets, and are able to significantly improve their terms-of-trade and welfare through raising protection. This implication is counterintuitive with casual empiricism, as a broad range of Chilean economists expressed the view that the Chilean optimal tariff for any product would be very low.[10] In fact, we show in appendix C that the optimal tariff t^* is bounded below by $t^* = \{[\sigma_{MM}/(\sigma_{MM}-1)] - 1\}$. Thus, even with $\sigma_{MM} = 30$, the optimal tariff is slightly over 3%. For those who believe that a small open economy like Chile cannot have a significant optimal tariff, the logical implication in this Armington specification is that they believe that these elasticities are quite high. To be clear, a value of $\sigma_{MM} = 30$ means that if Chile tried to raise its prices by 1 percent on world markets relative to an average of aggregate imports, Chilean imports would decline relative to aggregate imports by 30 percent. Given that there may be some economists who would prefer elasticities based on the econometric

[10]A small amount of computational inaccuracy is introduced with elasticities of substitution as high as 30; so welfare results for example, may not be precise beyond tenths of a percent of GDP.

estimates yielding lower elasticity estimates, despite the discomforting implications for the optimal tariff, we also perform most of our important policy simulations with $\sigma_{MM} = 8$ and $\sigma_{DM} = 4$. We refer to these as our low elasticities. A high elasticity scenario for a small open economy such as Chile would be a specification with still less market power for exports.

Production entails the use of intermediate inputs and primary factors (Labor, Capital and Land). Primary factors are mobile across sectors within a region, but are internationally immobile. Each region has a single representative consumer, as well as a single government agent. We assume CES production functions for value added[11], and Leontief production functions for intermediates and the value added composite. Exports are not differentiated by country of destination.

All distortions are represented as *ad valorem* price-wedges. These include factor taxes in production, value-added taxes, import tariffs[12], export subsidies, voluntary export restraints (represented as *ad valorem* export tax equivalents) and non-tariff barriers (represented as *ad valorem* import tariff equivalents). Lump-sum replacement taxes or subsidies ensure that government revenue in each region stays constant at real benchmark levels. For Chile, however, we capture the marginal efficiency cost of the government having to raise extra revenues through a distortionary domestic tax system. For developing countries these costs could be quite significant, since the revenue losses from trade reform could be sizeable.

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[11] The elasticities of substitution for these value added production functions are taken from Harrison, Rutherford and Wooton [1991; Table 1, p.101], which are unpublished estimates by Harrison, Jones, Kimbell and Wigle [1993] from time-series data for the United States between 1947 and 1982. Contrary to many of the estimates employed in the CGE literature, the econometric specification used in this case corresponds to the functional form assumed in the model.

[12] We also employ ancillary data on the bilateral tariffs of Chile, Argentina and Brazil with all of the regions in the GTAP database. These data are described in Appendix B.

4. Policy Results for Chile

Since it has a rather important impact on the welfare results, and the implications for government revenue are important in their own right, in this section we first discuss how Chile will replace the revenue it will lose from lowering its tariffs. Next we discuss the results of several simulations in our model to evaluate the preferential trade area policy options which have been discussed in Chile. Finally we consider related policies that Chile may adopt to optimize its trade policy options.

A. The Role of the Replacement Tax

Since Chile is reducing tariffs in most of our scenarios there is a revenue loss to the government. We impose a revenue neutral requirement in all simulations, and stipulate explicitly how the additional tax revenue will be generated. We employ either the existing VAT, a uniform VAT or a "Lump Sum" tax. First we discuss the welfare impact of the different replacement tax options and then the revenue impact.

Welfare Effects of the Replacement Tax. Collection of the existing VAT is not uniform in Chile: according to our estimates in Table 5, it ranges from 0 to 18 percent across sectors. Hence, raising revenue through the VAT generates distortions. That is, the VAT discriminates against the sectors with high effective VAT rates and, when increased, moves resources into less highly taxed sectors. This reduces any possible gains from the trade policy change. Results for welfare using the existing VAT are presented in column 1 of Table 1.

In fact, we have estimated the "marginal excess burden" (MEB) of the existing VAT in Chile to be equal to 7.6%. This implies that every extra 1000 pesos of revenue generated by raising the VAT results in an additional welfare loss, apart from the 1000 pesos transferred to government, of 76 pesos. In other words, consumers and producers will have to be taxed 1076 pesos for the government to receive 1000 pesos. The 76 pesos are simply lost to the Chilean economy.

We have also calculated the MEB of the Chilean tariff, and it equals 18.5%. Despite the fact that the tariff is uniform across sectors, and therefore imposes no intersectoral distortion costs, the Chilean tariff imposes a higher distortion cost than the VAT. This is because it discriminates geographically favoring domestic production over imports, whereas the VAT does not.

In column 5 of Table 1, we show the results of employing a "LUMP SUM" tax as the replacement tax. This tax avoids the distortions of a non-uniform VAT since the MEB for lump-sum tax replacement is, by definition, zero. Consumer income is taxed in a fixed amount independently of consumer choices, so that no resource allocation is affected. Hence we would expect that there would be an added welfare cost of using the VAT, as compared to the lump-sum alternative, to replace revenues. This is exactly what our overall welfare results show.

Finally, in column 3 of Table 1 we show the results of using a uniform VAT. In these scenarios we first counterfactually create an equilibrium in which all other domestic taxes and subsidies are zero and the VAT is uniform. The impact we evaluate is then due to the trade policy change alone. The uniform VAT will be a distortionless tax in our model. Since all sectors are taxed, and there is no labor-leisure choice, there is no way to take an action that will lower the tax. In other words, there are no resource allocation effects and the uniform VAT is essentially equivalent to a Lump Sum tax in our model. In addition, any "second best" interaction effects of distortions between

the tariff and the existing VAT will be removed if we start with a uniform VAT (for this reason the results for the Lump Sum tax and the uniform VAT may differ). In these scenarios, we equalize the VAT across sectors and solve for the level of the VAT that is required to compensate for the lost revenues.

Revenue Effects.

In column 2 of Table 1 we present the equiproportional increase in the VAT required to keep government revenue constant. For example, with central elasticities a free trade area with MERCOSUR will require a 45 % increase in the VAT rate across sectors. That means if the collected VAT rate is 10% in a sector (see Table 5), the collected VAT rate will have to increase to 14.5% percent. With central elasticities there is a strong substitution away from imports that pay tariffs in favor of imports from partner countries that are tariff free. Then the revenue requirements for the VAT are quite high in order to compensate for the lost tariff revenues. With low trade elasticities the revenue requirement for the VAT is much smaller, ranging from an increase between 17% and 26% in the three basic preferential trade arrangement scenarios presented in rows 1-3.

In columns 4 and 7 we show tariff revenues collected in the new equilibrium as a percentage of GDP. In our initial equilibrium, tariff revenues are equal to about 3.6% of GDP, but in the preferential trade area scenarios (rows 1-3), they fall to between 0.9% and 2.7% of GDP. Thus, in the preferential trade area scenarios, tariff revenues fall to between 25% and 75% of original tariff revenues. The loss of tariff revenue is higher with NAFTA (because NAFTA is a larger share of Chilean imports than MERCOSUR) and higher with central elasticities because of the greater trade diversion. Since the VAT revenues as a percentage of GDP constitute about 9% of GDP initially and,

depending on the preferential trade area and elasticities, the tariff loss is between 0.9% and 2.7% of GDP, if the VAT is employed as the replacement tax, it will be necessary for VAT revenues to increase by about 10% to 30%.

Some may question that the implied increase in the VAT is too high. To provide intuition for the model implications for the VAT, consider a particular scenario where the lost tariff revenue is about 2.5% of GDP, as in row 6 with central elasticities. It is estimated in Table 1 that the VAT rate will have to increase by 45% to a legal rate of about 26%. In 1994 the legal VAT rate of 18% generated VAT revenues of about 9% of GDP, i.e., the legal rate was twice the collected rate. Assuming no change in the rate of VAT evasion, it will be necessary to raise the VAT by 5% to generate 2.5% of GDP, i.e., from 18% to 23%. But the model predicts a required increase of the VAT rate to 26%, not 23%? The reason the model predicts an extra 3% increase in the legal VAT rate is that an increase in the tax will induce a shift away from the highly taxed sectors and an erosion of the tax base. Given model parameters, increases in the VAT continue to generate additions in revenue within the range under consideration; but it is possible a more realistic representation of the VAT in Chile would incorporate an increase in evasion rates with increases in the VAT rate or simply that the rate of VAT collection can not be increased in some sectors. Then the required legal VAT rate increase and distortion costs of revenue replacement would be still higher than we have estimated, or possibly the VAT is not a feasible tax to generate considerably more revenue with further reform in collection procedures.[13] Given the uncertainties of rates of evasion of VAT in

[13]To quantify these ideas, we have simulated Chile's FTA with MERCOSUR and NAFTA where we assume that the services and trade and transportation sectors can not have their collected VAT rates increased due to evasion. (These are the sectors with low rates of VAT collection and where evasion of the VAT may prevent additional collections; together they produce about 65% of Chilean value-added.) Then, with central elasticities, the welfare loss from the FTA with MERCOSUR is increased to -0.60% of GDP

Chile, these estimates should be taken as indicative of revenue requirements rather than as recommendations for the VAT rate. In fact, below we emphasize the importance of uniformity of collections.

B. Preferential Trade Area Options

The overall welfare results for the trade policy options are presented in Table 1. More detailed results on output, imports and exports for the main scenarios are displayed in Table 6. Welfare impacts are presented as a percent of GDP of Chile. They represent changes on a recurring, annual basis, so a 1% welfare gain should be interpreted as a 1% increase in real income *each and every year in the future.*

In the first row of Table 1 we present the results from the scenario where Chile forms a free trade area with MERCOSUR. We assume that each of the MERCOSUR countries represented in the model, Argentina and Brazil, reduce their tariffs on Chile's imports to zero and that Chile reduces its tariffs on imports from them to zero as well. None of the members of MERCOSUR are assumed to impose any export taxes or subsidies on each other either. Consistent with the agreement between Chile and the MERCOSUR customs union, we assume that Chile does *not* adopt the common external tariff of MERCOSUR in this scenario.

The second scenario, shown in row 2, represents Chile joining MERCOSUR as part of the customs union. In addition to the requirements of the scenario in row 1, in this case Chile adopts the common external tariff of MERCOSUR. Although Chile has not joined the MERCOSUR

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and the gains from the FTA with NAFTA are reduced to 0.12% of GDP. As expected, the required rate of VAT increase must increase to about 75%.

customs union, it is a potential policy option so we evaluate it in this scenario. For simplicity, we assume that the common external tariff that Chile adopts is the import tariff structure that Brazil currently has with the countries that are not in MERCOSUR.[14]

The third scenario, in row 3, is Chile forming a free trade area with NAFTA. In the scenario in which Chile forms a free trade area with NAFTA, Chile and the NAFTA countries provide each other tariff free access on trade with each other, but Chile retains its import tariffs against non-member countries. In row 4, primarily to help understand the results, we evaluate the consequences of an agreement between Chile and NAFTA in which Chile does not obtain improved access to the NAFTA market. After discussion of these scenarios, we introduce further simulations to help explain the results and evaluate modified options.

The effects on welfare are dependent on both how Chile chooses to replace the lost tariff revenues and on assumed elasticities. Chile's preferential trade policy options with MERCOSUR lead to a loss of welfare with our preferred central trade elasticities and negligible gains or losses with low trade elasticities. With central trade elasticities, in terms of Figure 1, this means that the trade diversion costs of an agreement with MERCOSUR typically dominate the trade creation effects. Moreover, based on the MERCOSUR external tariff, preferential access to the markets of

[14]This tariff structure is slightly different than the tariff structure shown for Argentina. There are two reasons for this. First, there are exceptions to the common external tariff for Argentina and Brazil, as both countries adapt their tariff schedules over time to the agreed common external tariff. In addition, Argentina and Brazil could well have adopted exactly the same common external tariff at a detailed tariff line level, but have different trade shares across these tariff lines. Then in aggregating with the different trade weights, the rates that appear in the GTAP database have the 24 sector level reflect differences in these trade patterns, and need not reflect differences in the common external tariff at the detailed tariff line level. For ease of comparison we also assume in our Chile customs union with MERCOSUR scenario that Argentina adopts the tariff of Brazil as its common external tariff. This provides a clean representation of the MERCOSUR customs union for our purposes.

MERCOSUR is insufficient to overcome this welfare loss in Chile's markets. Welfare losses are lower with lower assumed elasticities because the there is less trade diversion when Chile's consumers are less willing to substitute MERCOSUR'S products for those of the rest of the world.[15]

The results indicate that the customs union with MERCOSUR is an inferior outcome for Chile compared with a free trade agreement with MERCOSUR. The difference between the two policy choices is that with the customs union, Chile adopts the common external tariff of MERCOSUR reflected in Brazil's tariff. Inspection of Table 4 reveals that MERCOSUR's tariff structure is diverse compared with Chile's tariff (which is uniform). Since the welfare costs of trade restrictions tend to increase disproportionately with the height of the tariff, Chile is better off with its own uniform tariff.[16]

In comparing our results in rows 1-3 regarding Chile's preferential trade area options, the most important result is that the FTA with NAFTA is beneficial to Chile while the others are likely to present problems.[17] In order to ascertain the source of the gain to Chile from a FTA with NAFTA, we performed the simulation in row 4 in which Chile lowers its tariffs against imports from NAFTA countries but does *not* obtain improved access in NAFTA markets. Although this is not a policy option that Chile would adopt, the results of row 4 show that Chile loses from preferential reduction

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[15]These results are consistent with those of Donoso and Hachette [1996] and Muchnik, Errazuriz and Dominguez [1996]. Based on the results of the Muchnik et al. study which focused on agriculture, Donoso and Hachette estimated that access to the MERCOSUR market would not offer significant gains to Chile.

[16]"Ramsey optimal" tariffs will vary inversely with the elasticity of demand. Typically, however, departures from uniformity do not conform with Ramsey optimal rules, but rather with political economy considerations. Moreover, in our model the Ramsey optimal tariff is uniform.

[17]These results are consistent with results from the computable general equilibrium models of Coeymans and Larrain [1994]; Reinert and Roland-Holst [1996]; and Hinojosa-Ojeda, Lewis and Robinson [1995], all of whom found that Chile will gain from a free trade area with NAFTA.

of its tariffs against NAFTA countries without reciprocal access to NAFTA markets.

In order to identify even more precisely the source of the access gains from the FTA with NAFTA, we performed a simulation in which access to only one sector was not obtained: non-grain crops. Our estimates of the tariff distortions in Table 4 suggest that the United States tariff is likely to be central in this sector: there is a 20% tariff on non-grain crops.[18] We can consider the effects of Chile joining NAFTA but assuming no change in U.S. tariffs on non-grain crops. In other words, we can assume that Chile obtains access in all sectors except non-grain crops. Although not shown in Table 1, if Chile fails to obtain preferential access in non-grain crops, the welfare gains of 0.82% we obtained in the full access case (existing VAT replacement and central elasticities) now drop to a welfare loss of -0.58%. Thus access in non-grain crops is crucial to welfare gains from NAFTA.[19]

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[18]Although the GTAP database indicates that the U.S. tariff on non-grain crops is 47%, we have lowered this to 20% in our benchmark equilibrium for two reasons. First, we prefer updated estimates where possible. The most important non-grain crops products for Chile are fruits and vegetables, and post-Uruguay Round tariff rates for these products in the U.S. market are the relatively modest figures cited below in this footnote; the higher protection estimates for these products in the GTAP database (averaging 56%) were derived from an average of protection estimates in the 1989-1994 period. Second, the U.S. protection on these products varies with the season. We have assumed that given production in the opposite hemispheres, when Chilean fruits and vegetables are ready for harvest and export to the U.S., they would typically face U.S. tariffs that are in the low range of the seasonal tariffs applied by the United States. Products included in the non-grain crops category of the GTAP database (along with the estimated tariff and tariff equivalent of the non-tariff barrier in the U.S.) are: sugar, 67%; oilseeds, including peanuts, 25%; coffee, cocoa and tea, 0%; cotton, 31%; vegetables (fresh, 0-25%; frozen, 17.5-25%; dried, 25-35%, prepared and preserved, 13.6-14.7%); fruits (fresh, 0-20%, dehydrated, 0.6-2.2%; frozen, 0.7-14%; juices, 0-31.3%; jams and pastes, 7.0-35%; canned, 1.9-20%); and other non-food crops (tobacco, jute, etc), 19%.

The reduced estimates are closer to the estimates of Butlemann and Meller [1995, p376]. They report that Chilean fresh, frozen and canned vegetables face MFN tariff rates in the United States ranging from 9.5 to 17.5 percent (with a few percentage reduction for the former two categories where GSP treatment applies), and that Chilean fruits face United States MFN tariffs from 1 to 10 percent.

[19]Since U.S. protection in milk products is also high, we examined the impact of denial of improved access in NAFTA markets for Chilean products on both non-grain crops and milk products. Chile exports very little milk products, however, so the welfare result was only slightly more adverse for Chile (-0.60% of GDP with central elasticities and existing VAT replacement) relative to denial of Chilean access in non-grain crops alone.

These results demonstrate the importance of improved access emphasized by Wonnacott and Wonnacott [1981]. Our results show that Chile can gain more from a FTA with NAFTA than it can from global free trade, a result which is dependent on the fact that Chile starts with a low and uniform tariff as we elaborate below. But Chile can expect to lose from *any* of the preferential trade agreements we have considered if there is no improvement in access to partner country markets.

These results contrast with some others we have found for other small open economies forming preferential trade areas with large markets, such as Morocco, Turkey and Tunisia with the European Union (e.g., see Rutherford, Rutström and Tarr [1993] and Harrison, Rutherford and Tarr [1996b]). One important reason for the difference in results with these other countries is that Chile has a low and uniform tariff. That is, although it is not true as a general proposition, the implementation of a preferential trade agreement in a country that starts with a dispersed tariff structure may result in a reduction in the dispersion of the tariff structure. Potential benefits from a reduction in the dispersion of the tariff, however, are ignored in more aggregated theoretical analyses of preferential trade arrangements, such as that of Figure 1.[20] To verify this intuition we have counterfactually created an initial equilibrium in which Chile applies a 22% tariff on one-half of its imports and a zero tariff on all others, and then implemented the policy scenarios in rows 1-4 of Table 1 (where we have employed existing VAT replacement and central elasticities). The sectors with the high tariffs were selected at random and the experiment was repeated 206 times. The means

[20]There is value in further theoretical work into the generality of the impact of preferential arrangements on uniformity, as well as the gains from moving to uniformity when tariffs depart from uniformity for political economy reasons. We know that if elasticities are not equal, "Ramsey" optimal revenue producing tariffs are not uniform. In our model, however, elasticities are equal across sectors, so the Ramsey optimal tariff is uniform. A useful exercise would be to evaluate the impact of a preferential trade arrangement where we start from randomly selected elasticities across sectors, and see how often Chile gains from preferential trade agreements as we use a large number of distinct sets of elasticities.

of the distributions for welfare as a percent of GDP are as follows: free trade area with MERCOSUR, -0.56%; customs union with MERCOSUR, -0.44%; free trade area with NAFTA, 1.47%; and free trade area with NAFTA but no improved access, -0.52%.

The gains the free trade area with NAFTA are significantly larger when based on the hypothetical non-uniform initial tariff structure and the losses from the free trade area with MERCOSUR are slightly smaller, reflecting a movement toward uniformity. But losses from a preferential reduction of tariffs toward the NAFTA markets remain (albeit at a lower level) unless access to NAFTA market is obtained.

In this hypothetical experiment in which Chile starts with a diverse tariff structure, we find that the ranking of the customs union with MERCOSUR versus the free trade area with MERCOSUR is reversed compared with the actual situation represented by Table 1. Although Chile still loses from both preferential trade agreements with MERCOSUR, it is intuitive that the customs union produces less losses than the free trade area because the common external tariff of MERCOSUR is more uniform than the Chilean tariff in this hypothetical situation. In the actual situation of Table 1, the customs union with MERCOSUR represents a movement away from uniformity.

Thus, a key to understanding the results for Chile is to recognize that, contrary to many other countries implementing preferential trade agreements, Chile starts with a relatively distortionless external trade regime. Not only is their low average tariff important, but the uniformity is also important. Then, there is relatively little Chile can do to improve resource allocation *within* Chile through preferential trade arrangements. Significant gains can only come through improved preferential access as well as improvements in its domestic tax structure.

Finally, we note that our model assumes perfect competition. Rutherford and Tarr [1997] have shown that when imperfect competition and the dynamic gains from trade are taken into consideration, there may be large additional gains from liberalizing trade with a large technologically advanced country. Reducing protection against such a country could induce additional imports of technologically advanced products (or additional varieties) that would lower production costs and increase incomes in the importing country (Romer [1993] has made a similar argument). This would indicate that a multilateral trade liberalization or a preferential trade arrangement with a technologically developed region such as NAFTA would provide additional benefits to Chile in addition to those estimated here.

C. Optimizing Chile's Trade Policy Options

In rows 5-9 of Table 1, we evaluate a number of trade and tax options that are open to Chile. Consistent with intuition gleaned from Figure 1, we know that Chile can reduce the trade diversion costs of preferential trade areas if it lowers its external tariff. Thus, a number of economists (including Schiff [1996], Corbo [1996] and Leipziger and Winters [1996]), have recommended that Chile combine a reduction of its tariff on third countries with any possible free trade agreements. In rows 5 and 6 we evaluate the two free trade area options with a simultaneous reduction of the tariff to 6%. In rows 7 and 8 we evaluate the impact of lowering the external tariff to 8% and 6% on a multilateral basis. We evaluate going to global free trade in row 9.

Before discussing the estimates of the benefits of unilateral and multilateral trade liberalization in rows 7, 8 and 9, we first explain why Chile may have a small optimal tariff despite being a small country. If Chilean exports are differentiated from the products of other countries so

that Chile in aggregate faces a downward sloping demand curve for a product (even if individual Chilean producers do not perceive a downward sloping demand curve), then there will be an optimal export tax to maximize Chilean export profits. The height of the optimal export tax will be inversely related to the elasticity of demand faced by Chile in world markets,[21] which is in turn determined by how substitutable Chile's products are with those of other countries. In the limit, when Chilean products are perfect substitutes in all its export markets for products from all other countries, Chile has no ability to obtain a higher price by restricting its exports; so the optimal export tax is zero.

Although Chile imposes virtually no export taxes, we know from the Lerner symmetry theorem that import tariffs are equivalent to export taxes. Since we must have equilibrium in the balance of trade, any reduction in exports must equal the reduction in imports, and conversely. Hence an import tariff can be employed to exploit any market power Chile will have on its exports.[22] It is for this reason that Chile may have an optimal import tariff.

In our central elasticity scenarios we have assumed that all countries have an elasticity of substitution between imports from different countries (σ_{MM}) equal to 30.[23] Then there will be very little market power for Chile in its export markets, because if it raises the price of its products, other countries will rapidly shift to alternate suppliers. Nonetheless, even in our central elasticity

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[21]Individual competitive firms will price at their marginal costs, but since the country as a whole must accept a lower price to sell more, there is an optimal export tax that equates the marginal revenue received from exports equal to the marginal costs. The more elastic the demand, the lower the optimal export tax.

[22]An import tariff will appreciate the real exchange rate by restraining imports. Then exporters will receive less in terms of domestic goods for a unit of exports, and exports will decrease to achieve equilibrium with the lower value of imports.

[23]This means that in Chile's export markets, if Chilean prices become 10% cheaper relative to prices of other imports, demand for Chile's exports will increase by 300% relative to the demand for other imports.

scenarios, Chile does not face a perfectly elastic demand curve. We show in the appendix that the optimal tariff t^* is bounded below by $t^* = \{[\sigma_{MM}/(\sigma_{MM}-1)] - 1\}$. Thus, even with $\sigma_{MM} = 30$ the optimal tariff is over 3%; but in our low elasticity scenarios, with $\sigma_{MM} = 8$, the optimal tariff is over 14%. In our alternate high elasticity model formulation, the optimal tariff is virtually zero.

Considering the preferential trade options in rows 5 and 6, we see that there is the expected increase in the estimated welfare gains compared with rows 1 and 3, respectively. With central elasticities there is a significant improvement in welfare compared with an 11% external tariff; with low elasticities, the adverse terms-of-trade effect of reducing tariffs mitigates the welfare gain from reducing the trade diversion costs. This shows that as long as Chile limits itself to a free trade area it can profit from the increased access it obtains in its partner countries without excessive trade diversion costs, provided it lowers its external tariff sufficiently.

In rows 7 and 8 we present the estimates of the welfare and replacement tax implications to Chile of unilaterally and multilaterally lowering its external. With central elasticities and distortionless domestic taxes (Lump Sum or uniform VAT), multilateral reduction of the tariff to 6% increases welfare, and there are further gains from reducing tariffs from 8% to 6%. With the existing VAT as the replacement tax, reducing the tariff to 8% increases welfare, but the distortion costs of the VAT are sufficiently close to the tariff that combined with the small adverse terms of trade effects, there are no further gains from tariff reduction below 8%. With a distortionless replacement tax, reduction of the external tariff to zero produces positive welfare gains compared with the 11%

tariff (row 9); but since the gains are less than reduction to 6% (row 8) the optimal tariff is between 0 and 6%.[24]

With existing VAT replacement there is some limited scope for beneficial reduction of the tariff with central elasticities. Again, with higher elasticities, the optimal tariff is lower and the gains from tariff reduction would increase.

D. Sectoral Impacts

In Tables 6 and 7 we present the impacts on output, exports and imports at the 24–sector level from three of the principal trade policy options: the free trade area with MERCOSUR, the free trade area with NAFTA, and multilateral reduction of the tariff to 8%. Focusing on the percentage change in output with central elasticities, the sectors that significantly expand with the free trade agreement with MERCOSUR are transportation (dramatically),[25] machinery and equipment, iron and steel, and milk. With the free trade agreement with NAFTA the sectors that expand more than 10% are: iron and steel, transportation equipment, milk, non-grain crops, and textiles. With multilateral tariff reduction the expanding sectors are transportation equipment, iron and steel, and to a lesser extent non-ferrous metals and mining.

Iron and steel and transportation equipment expand under all three trade policy options, but the other expanding sectors differ. Iron and steel and transportation equipment are both small sectors

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[24]In fact, we have separately calculated the optimum tariff with central elasticities at between 3 and 4% and with the low elasticities about 14%, assuming Lump Sum replacement of tariff revenues in each case.

[25]Although the expansion is dramatic in percentage terms, it is starting from a very small base. Thus the absolute increase is plausible.

in Chile; in Table 3 we note that each sector produces less than 1% each of Chilean value-added. However, these are the two sectors that export the most intensively; both export over 90% of their output (see Table 4). Either preferential or multilateral tariff reduction induces a depreciation of the real exchange rate, which makes exporting more profitable and gives a boost to the sectors which export intensively.

With multilateral tariff reduction the other sectors which expand (non-ferrous metals and mining) are also the ones that export a high percentage of their output. So the real exchange rate impact and export intensity explains well the pattern of expanding and contracting sectors with multilateral tariff reduction.

With a free trade agreement with NAFTA, textiles, milk and non-grain crops expand, in addition to the two or three most export intensive sectors, because these three sectors obtain a substantial improvement in their terms-of-trade in the U.S. market. We have discussed earlier how improved access to non-grain crops and milk is crucial to an improvement in Chilean welfare from NAFTA, and these sectoral results are consistent with those welfare results.

With the free trade agreement with MERCOSUR, machinery and equipment and milk expand in addition to transportation and iron and steel. Our data (see Table 4) indicate that these two sectors are two of the most highly protected in MERCOSUR, so these sectors obtain relatively greater improvement in their terms-of-trade after implementation of a free trade agreement with MERCOSUR, which induces their expansion.

5. Conclusions

Butlemann and Meller [1995] have articulated the strategy of the government of Chile which is to negotiate bilateral free trade agreements with many governments, especially its significant and willing trading partners. This they argue will progressively lower the effective average tariff and, crucially, will help to assure stability of access to the markets of partner countries. The free trade agreement in late 1996 between Chile and Canada in which both countries agreed to eschew antidumping actions against each other is regarded as a notable example of the advantages that the bilateral approach offers. An opposing view within Chile is offered by Donoso and Hachette [1996] who argue that the limited market access of at least some of the bilateral agreements (e.g. MERCOSUR) is not worth delaying the benefits of opening up unilterally and multilaterally, and they fear that some bilateral arrangements may restrict broader opening up.

Our results provide some insight into this debate, but are not definitive. We show that without complementary reduction of the external tariff, the MERCOSUR agreement will be counterproductive, i.e., undisciplined bilateralism has problems. On the other hand, we show that the free trade agreement with NAFTA offers more gains than any of the unilateral options, largely due to the benefits of preferential access to the U.S. market. But Chile is foregoing the benefits of unilateral and multilateral trade liberalization in the short to medium term for the prospect of gains in the future of a free trade area that includes the United States. Whether this tradeoff will prove beneficial is beyond the scope of our model.

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Table 1: Welfare and Government Revenue Results for Chile's Trade Policy Options

Policy Simulation	With Replacement Taxes As:					Combined Effect of Uniform VAT and Trade Policy a/	
	Existing VAT		Uniform VAT a/		Lump Sum		
	% change in welfare c/	% change in VAT d/	% change in welfare c/	tariff revenue % of GDP	% change in welfare c/	% change in welfare c/	tariff revenue % of GDP
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1. FTA with Mercosur (central elasticities)	-0.62	45	-0.40	1.7	-0.43	-0.19	1.8
(low elasticities)	0.04	17	0.07	2.7	0.08	0.19	2.7
2. Customs Union with Mercosur (central elasticities)	-0.95	52	-0.74	1.3	-0.73	-0.62	1.2
(low elasticities)	-0.20	21	-0.22	2.5	-0.17	-0.14	2.5
3. FTA with NAFTA (central elasticities)	0.82	48	1.03	0.9	1.04	1.23	0.9
(low elasticities)	0.30	26	0.31	2.1	0.38	0.43	2.1
4. FTA with NAFTA, without improved access (central elasticities)	-1.11	62	-0.92	0.7	-0.83	-0.64	0.7
(low elasticities)	-0.47	30	-0.45	2.0	-0.41	-0.33	2.0
5. FTA with Mercosur and 6% external tariff (central elasticities)	0.12	49	0.44	1.7	0.35	0.61	1.7
(low elasticities)	0.06	38	0.11	1.7	0.13	0.21	1.7
6. FTA with NAFTA and 6% external tariff (central elasticities)	1.46	45	1.72	1.1	1.70	1.89	1.1
(low elasticities)	0.41	41	0.45	1.4	0.49	0.55	1.4
7. Reduce external tariff to 8% (central elasticities)	0.02	16	0.12	2.9	0.10	0.41	2.9
(low elasticities)	-0.11	17	-0.08	2.7	-0.06	0.03	2.7
8. Reduce external tariff to 6% (central elasticities)	0.01	28	0.16	2.3	0.11	0.43	2.3
(low elasticities)	-0.18	30	-0.14	2.1	-0.14	-0.04	2.1
9. Reduce external tariff to zero (central elasticities)	-0.26	76	0.02	0	0.09	0.21	0
(low elasticities)	-0.54	72	-0.45	0	-0.42	-0.37	0

a/ In these scenarios, we first create an equilibrium with a uniform VAT, no other domestic taxes, then evaluate the "pure" effects of the trade policy.
b/ These scenarios combine the impacts of the trade policy simulation with going to a uniform VAT and elimination of the domestic output tax, government revenues held constant.
c/ Percentage change in Hicksian equivalent variation as a percentage of GDP.
d/ Required equiproportional increase in the VAT rate across all sectors to keep government revenues unchanged.

Table 2: Commodities, Regions & Factors of Production in the Chile Model

Commodities

WHT	Wheat
GRO	Other Grains
NGC	Non-grain crops
WOL	Wool and Other livestock
FRS	Forestry
FSH	Fishing
ENR	Energy products
MIN	Mineral products
MEA	Meat products
MIL	Milk products
FOO	Other food products
B_T	Beverages and tobacco
TEX	Textiles and apparel and leather products
LUM	Lumber and wood
PPP	Pulp and paper
CRP	Chemicals rubber and plastics
I_S	Primary ferrous metals
NFM	Non-ferrous metals
FMP	Fabricated metal products
TRN	Transport industries
MAC	Machinery and equipment
T_T	Trade and transport
SER	Services
CGD	Savings good

Regions

CHL	Chile
ARG	Argentina
BRA	Brazil
RSM	Rest of South America
USA	United States of America
CAN	Canada
MEX	Mexico
CAM	Central America and Caribbean
E_U	European Union 15
JPN	Japan
ROW	Rest of World

Factors

LND	Land
LAB	Labor
CAP	Capital

Table 3: Structure of Economic Activity in Chile

VA	Value added net of tax ($ millions)
VA%	Sectoral value added as a percent of aggregate value added
LVS%	Labor share of value added, in percentage form
EXPORT	Value of exports
EXPORT%	Sector exports as a percent of aggregate exports
IMPORT	Value of imports
IMPORT%	Sector imports as a percent of aggregate imports

Sectors	VA	VA%	LVS%	EXPORT	EXPORT%	IMPORT	IMPORT%
WHT	171	1	30			92	1
GRO	76		30	32		75	1
NGC	1428	6	37	1413	11	187	1
WOL	520	2	30	31		20	
FRS	132	1	29	93	1	1	
FSH	411	2	51	548	4	9	
ENR	507	2	39	39		1381	10
MIN	1185	5	45	1542	12	227	2
MEA	97		66	27		93	1
MIL	60		46	7		74	1
FOO	516	2	48	1108	9	307	2
B_T	130	1	66	144	1	74	1
TEX	312	1	61	206	2	1004	7
LUM	356	2	45	510	4	57	
PPP	405	2	49	739	6	275	2
CRP	548	2	58	435	3	1633	11
I_S	16		45	75	1	391	3
NFM	930	4	45	3194	25	89	1
FMP	213	1	61	63		270	2
TRN	22		53	148	1	2325	16
MAC	80		71	232	2	3817	27
T_T	4753	21	41	1240	10	886	6
SER	10104	44	61	832	7	1092	8

Source: GTAP Database (version 3, preliminary)and model assumptions.

Table 4: Structure of International Trade in Chile

EXPORT%	Sector exports as a percentage of domestic output
IMPORT%	Sector imports as a percentage of domestic demand
TM_AVE%	Import-weighted tariff rate (%)
TX_AVE%	Export-weighted export tax rate (%)
XT_AVE%	Export-weighted average tariff applied to Chilean exports (%)
TXT_BRA%	Tariff applied to Chilean exports by Brazil (%)
TXT_USA%	Tariff applied to Chilean exports by USA (%)

Sector	EXPORT%	IMPORT%	TM_AVE%	TX_AVE%	TXT_AVE%	TXT_BRA%	TXT_USA%
WHT		17	11		5	5	
GRO	16	30	11		23	8	
NGC	44	9	11		42	6	20
WOL	2	2	11		3	5	3
FRS	32		11		6	2	
FSH	43	1	11		7	10	4
ENR	1	29	11		9		
MIN	41	9	11		1	6	4
MEA	2	7	11		114	11	13
MIL	1	12	11		33	16	92
FOO	24	8	11		9	11	7
B_T	16	9	11		20	17	9
TEX	9	33	11	4	23	16	16
LUM	40	7	11		5	12	2
PPP	42	21	11		4	8	
CRP	14	39	11	2	12	9	7
I_S	91	98	11		11	12	11
NFM	74	7	11		3	7	5
FMP	5	20	11		21	16	2
TRN	99	100	11		21	17	2
MAC	39	91	11		15	15	5
T_T	9	7	11				
SER	4	5	11	9			

Source: GTAP Database, version 3 (preliminary) and World Bank calculations

Table 5: Benchmark Domestic Tax Rates in Chile (percent)

Sectors	VAT	TY
WHT	17.2	2.7
GRO	17.2	2.7
NGC	16.8	2.8
WOL	3.8	0.6
FRS	1.8	1.3
FSH	6.9	0.8
ENR	14.2	12.1
MIN		0.3
MEA	18.0	-0.1
MIL	18.0	0.3
FOO	18.0	0.1
B_T	18.0	27.6
TEX	18.0	0.5
LUM	18.0	0.9
PPP	18.0	0.7
CRP	14.2	0.5
I_S	6.1	0.8
NFM	17.6	0.9
FMP	11.5	0.2
TRN	9.8	-1.3
MAC	10.3	0.7
T_T	2.8	2.2
SER	3.0	2.2

Source: Appendix A.

Table 6: Effects of Policies on Chilean Production and Trade
Central Elasticities and Existing VAT Replacement

OUTPUT: Percent change in domestically produced output in Chile
EXPORT: Percent change in Chilean exports
IMPORT: Percent change in Chilean imports
IMP_ARG: Percent change in Argentinian imports
IMP_BRA: Percent change in Brazilian imports
IMP_USA: Percent change in US imports

Free Trade Area with Mercosur--central elasticities and existing VAT replacement

	OUTPUT	EXPORT	IMPORT	IMP_ARG	IMP_BRA	IMP_USA
WHT	-5	-1	-14	10		
GRO	-27	-18	36	6	-3	-2
NGC	-4	2	46	10	4	
WOL	-6	14	92	-6	3	
FRS	-5	1	24	8	4	
FSH	-6	-1	36	4		
ENR	-7	2	7	-20	1	
MIN	3	13	59	1	32	
MEA	-6	12	58	4	-6	
MIL	50		-3	2	-1	
FOO	-11	-1	88	17	3	-1
B_T	1	18	13	9	10	
TEX	-11	20	17	-2	-2	
LUM	-7	-6	53	15	-3	
PPP	-15	-6	37	8	7	
CRP	-22	-9	23	-15	-1	
I_S	101	60	18	3	-6	
NFM	1	3	182	22	50	-1
FMP	-1	24	60	-7	3	
TRN	2523	2525	38	11	3	
MAC	105	164	-3	-4	-1	
T_T	-1	4	23	3	1	
SER	-1	10	45	13	9	

Free Trade Area with NAFTA--central elasticities and existing VAT replacement

	OUTPUT	EXPORT	IMPORT	IMP_ARG	IMP_BRA	IMP_USA
WHT	-59	-71	124	5		-1
GRO	-78	-75	137	-6	1	-9
NGC	46	98	73	-1	-1	2
WOL	-17	-28	349		-1	-1
FRS	-8		18	-1	-1	
FSH	1	8	-13			
ENR	-4	3	9	-1		
MIN	5	11	75		1	
MEA	-10	-23	61	-1	-2	-1
MIL	81	2	-1			
FOO	-11	-5	72			1
B_T	-1	27	55			1
TEX	15	155	13			
LUM	-9	-6	96			
PPP	-29	-26	53		-1	
CRP	-35	-8	32			
I_S	771	458	5			1
NFM	9	13	26	-1	-4	4
FMP	-11	-5	82			
TRN	123	123	3			
MAC	-13	4	3			
T_T	-2	4	103	-1		
SER	-1	16	111	-1	-1	

Reduce External Tariffs to 8 Percent--Central elasticities and Existing VAT replacement

	OUTPUT	EXPORT	IMPORT	IMP_ARG	IMP_BRA
WHT	-9	-4	19	-1	
GRO	-8	-3	15		
NGC	1	5	20		
WOL	-2	4	13		
FRS	1	7	8		
FSH	2	4	15		
ENR	-3	5	5		
MIN	4	7	22		1
MEA	-2	3	14		
MIL			1		
FOO	-1	3	16		
B_T		6	10		
TEX	-8	-3	10		
LUM	-1	2	22		
PPP	-3	1	9		
CRP	-8	-2	7		
I_S	54	32	1		
NFM	8	11	5	1	2
FMP	-1	5	17		
TRN	60	59	1		
MAC		2	1		
T_T		6	16		
SER		5	18		

Table 7: Effects of Policies on Chilean Production and Trade
Low Elasticities and Existing VAT Replacement

OUTPUT: Percent change in domestically produced output in Chile
EXPORT: Percent change in Chilean exports
IMPORT: Percent change in Chilean imports
IMP_ARG: Percent change in Argentinian imports
IMP_BRA: Percent change in Brazilian imports
IMP_USA: Percent change in US imports

Free Trade Area with MERCOSUR--Low Elasticities and Existing VAT Replacement

	OUTPUT	EXPORT	IMPORT	IMP_ARG	IMP_BRA
WHT	-4	2	14	1	
GRO	-7	-3	14	2	
NGC	-1		11	4	1
WOL	-1	5	10	2	1
FRS			4	1	1
FSH	-1		4	10	
ENR	-2	1	2	1	
MIN	1	4	12	1	7
MEA	-1	7	16	2	
MIL	-1	13	1	1	
FOO	-1	2	20	8	2
B_T	1	5	4	3	2
TEX		18	4	4	
LUM	-1	-1	8	6	1
PPP		3	9	5	2
CRP	-3	4	5		
I_S	10	6	2	1	
NFM	1	1	26	13	10
FMP	-1	10	12	3	
TRN	161	162	4	2	
MAC	19	39			
T_T		1	2		
SER		2	5	2	1

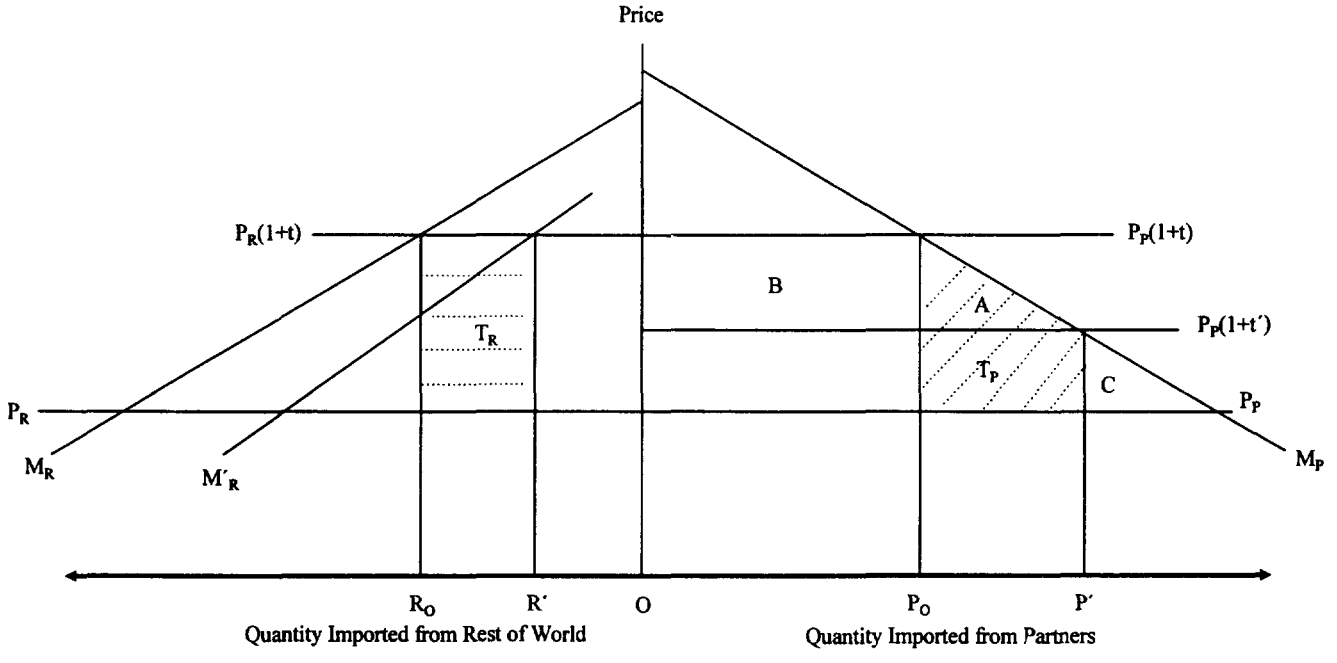
Free Trade Area with NAFTA--Low Elasticities and Existing VAT Replacement

	OUTPUT	EXPORT	IMPORT	IMP_ARG	IMP_BRA	IMP_USA
WHT	-7	-17	18			
GRO	-13	-12	23	-2		-1
NGC	15	33	11	-1	-1	2
WOL	-3	-8	31			
FRS	-2		4			
FSH	1	3		-1		
ENR	-1		2			
MIN	1	3	12			
MEA	-3	-8	7			
MIL	1	6	-7			
FOO	-2	-1	11	-1		
B_T	1	13	15			
TEX	3	46	6	-1		
LUM	-3	-3	19			
PPP	-5	-5	13			
CRP	-5	4	9			
I_S	20	12	-1			
NFM		1	5	-1	-1	1
FMP	-3	-1	11			
TRN	9	10	1			
MAC	-5	2	2			
T_T	-1	1	15			
SER		4	16			

Reduce External Tariffs to 8 Percent Multilaterally--Low Elasticities and Existing VAT Replacement

	OUTPUT	EXPORT	IMPORT	IMP_ARG	IMP_BRA
WHT	-2		7		
GRO	-3		5		
NGC		2	7		
WOL	-1	3	4		
FRS	1	4	4		
FSH	1	2	6		
ENR	-1	4	2		
MIN	2	5	5		1
MEA	-1	2	5		
MIL	-3		4		
FOO	-1	2	6		
B_T		4	4		
TEX	-2	1	3		
LUM		1	8		
PPP	-1	1	4		
CRP	-2	1	3		
I_S	9	6			
NFM	2	3	6	1	1
FMP	-1	2	6		
TRN	11	12			
MAC	-1	3	1		
T_T		4	4		
SER		4	5		

Figure 1: Trade Creation and Trade Diversion with Differentiated Products



If tariffs are reduced preferentially against partner country imports from t to t', the welfare change is equal to $A + T_P - T_R$, which is positive for small tariff changes. Further preferential tariff reduction obtains portions of the triangle C as gains against rectangles adjacent to T_R as losses. Since the height of the rectangles on the left are unchanged, but the height of remaining triangles on the right shrink, eventually further preferential tariff reduction results in net losses.

Appendices to:

Trade Policy Options for Chile:
A Quantitative Evaluation

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Appendix A

ESTIMATES OF INDIRECT TAX RATES FOR CHILE

Isidro Soloaga
The World Bank

Introduction and main results

We estimated effective **Value Added Tax (VAT)** rates and effective Other **Indirect Tax** rates for Chile. The principal data source was the Input-Output Tables for 1986 (IOM) estimated by the Central Bank of Chile, but the value-added base on the IOM was rescaled such that the rates were consistent with the aggregate collected net VAT rate based on information from the Ministry of Finance[1] . Other indirect taxes, taken from the IOM, include property taxes and license fees, and notably in the cases of tobacco and fuels special taxes. Table 1 presents the main results[2]. Explanation of the methodology employed is provided below.

To get an approximation of VAT evasion, many authors calculated the potential tax base from an Input Output Table and, by multiplying it by the nominal VAT rate, obtained the potential revenues to the government.[3] See, for instance, Marcel (1987), Serra (1991), Silvani and Medina (1989), Silvani and Brondolo (1993), and Aguirre and Parthasarathi (1993). Serra and Toro (1994) examined efficiency of tax collection in Chile more broadly. Although those studies were not designed to calculate the effective VAT rates by sector, these become by-products of the analysis: to get the effective VAT rates one may divide the VAT revenues by sector by the VAT potential base by sector[4].

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[1] Estadisticas de las Finanzas Publicas 1987-1995. Ministerio de Hacienda. Direccion de Presupuestos, p. 77

[2] The IOM provides data on: taxes on intermediate consumption by origin (domestic or imported inputs); indirect taxes that affect goods and services (i.e., Tobacco and Fuels); indirect taxes that affect activities rather than goods and services (e.g., Real State and Licenses taxes); and information of the Value Added Tax (VAT) by origin (domestic or imported goods and services).

[3] One minus the ratio of effective to potential VAT revenues gives an estimate of the degree of VAT tax evasion**.**

[4] An additional source of information on effective VAT and output tax rates by sector in Chile is the GTAP database (see Gelhar et al. (1996)). We have employed the GTAP database for the input-output tables and the trade flows in our model. However, despite discussions with the author of the estimates, it was not possible to reproduce the VAT and domestic output tax rate data of the GTAP database from publicly available sources.

Despite the existence of these high quality studies on the Chilean VAT system, for our purposes we found it necessary to perform independent calculations. Our estimates share with those previous studies the need to calculate the potential VAT base and to have adequate estimates of the VAT collected by sector. But in general, we required estimates at a more disaggregated level than was available in these studies, and in some cases the data used in the studies were either not documented or were not the most recent publicly available.

For example, the paper by Serra (1991) is one of the best papers to estimate tax evasion by sector in Chile.[5] He also used information from the IOM to calculate the potential VAT base; but the VAT payments data by sector are unpublished data from the Central Bank and the Ministry of Finance. Although it is useful to have additional data and estimates as a cross-check on estimates based on the known data sources, we preferred to employ data that were publicly documented. Moreover, although estimates in his paper exist for 17 sectors, this is not sufficiently disaggregated for the purposes of our model.[6]

TABLE A.I. Estimated Value Added and Indirect Output tax rates.

Sector	**VAT rate**	**Tax on output**
WHT Wheat	17.3%	2.7%
GRO Other Grains	17.3%	2.7%
NGC Non Grain crops	16.8%	2.8%
WOL Wool and Other livestock	3.8%	0.6%
FRS Forestry	1.9%	1.3%
FSH Fishing	6.9%	0.8%
MIN Mineral products	0.0%	0.3%
ENR Energy products	14.3%	12.1%
MEA Meat Products	18.0%	-0.1%
DAI Milk Products	18.0%	0.3%
FOO Other food products	18.0%	0.1%
B_T Beverage and Tobacco	18.0%	27.6%
TEX Textiles and apparel and leather product	18.0%	0.5%
LUM Lumber and wood	18.0%	0.9%
PPP Pulp and Paper	18.0%	0.7%
CRP Chemicals rubber and plastics	14.2%	0.5%
NFM Non ferrous metals	17.7%	0.9%
I_S Primary ferrous metals	6.1%	0.8%
FMP Fabricated metal products	11.5%	0.2%
MAC Transport industries	10.3%	0.7%
TRN Machinery and equipment	9.8%	-1.3%
T_T Trade and transport	2.8%	2.2%
SER Services	2.8%	2.2%

[5] We thank Pablo Serra for providing the data he employed in his study and for several instructive discussions.

[6] The most notable problem sector for our purposes is the manufacturing sector which is disaggregated in his study into Textiles and Other Manufactures.

Sector	VAT rate	Tax on output
CGD Savings goods	1.3%	2.2%
TOTAL	**9.1%**	**2.4%**

Data sources and assumptions

What follows is a description of the assumptions made in the calculations and a detailed list of the sources utilized. A table that shows each of the steps of the calculations is attached as Annex II.

1. Aggregation: The IOM presents information for 75 goods and activities that where aggregated into 24, as our model requires. The mapping from the 75 activities to the 24 is detailed in ANNEX I.

2. Value added tax: The VAT is a tax on transactions of goods and services. The VAT contained in input purchases is denominated "credit" and the VAT charged on sales is a "debit". Firms and individuals affected by the tax pay to the government the difference between credit and debit:

Debit = 0.18*Value of sales
-Credit = 0.18*Value of input purchases
VAT = 0.18(value of sales-value of inputs purchases).

That is to say, the VAT is 18% of the value added (sales-inputs). Nonetheless, some characteristics differentiate the VAT base in Chile base from the general concept of value added :

a) Some sectors are exempt from the tax. These sectors can not take as credit the VAT contained in their inputs and their sales do not generate a credit to their buyers.
b) The VAT contained in purchases of capital goods are considered as credit to the buyer.
c) Exports generate a rebate of the VAT paid on input purchases.

Thus, to calculate the VAT base we need to make some adjustments to the concept of value added from National Accounts. This has been done in many estimations of VAT compliance . We follow here with some modifications the approach presented by Marcel (1986). Using information from the IOM for 1977, he calculated the potential VAT base for Chile as follows[7]:

(1)Gross Value of Production, at producer price

[7] Diez anos del IVA en Chile. M. Marcel, Coleccion Estudios CIEPLAN, # 19, 1986. pp. 83-134. We added here between brackets a short explanation of the rationale for adding or subtracting each term.

-(2)Variations in Stocks (part of the increment in stock levels increases VAT credit to the firm)
-(3)Exports (all exports have a rebate of the VAT)
-(4)Gross value of production of goods and services exempted from the TAX
=(5)Gross Value of Production affected by the VAT

To this concept of Gross Value of Production affected by the VAT, other adjustments follow:

(5)Gross Value of Production affected by the VAT
-(6)Intermediate Consumption (part of it generates a VAT credit to the firm, the part that does not, is added below in 7)
+(7)Intermediate Consumption exempted from VAT (it does not generate credit)
+(8)Investment (Firms can take the VAT paid on investment as a credit)
-(9)VAT effectively paid to the Government (equal to VAT revenues to the tax collecting agency)
-(10)Other taxes (special VAT on certain goods, etc.)
=(11a)VAT POTENTIAL BASE (VAT-PB)

We approximate this value with data from the IOM. Information for items (4) and (7) were not available, and we did not include them, assuming implicitly that they cancel each other out. We also modified the calculation of the base of the VAT, by including imports. In this way, the estimated VAT base by sector could be matched with the VAT revenues by sector as it is presented in the IOM tables is [8]:

(1)Gross Value of Production, at producer price + Imports
-(2)Variations in Stocks
-(3)Exports
=(5)Gross Value of Production + Imports , affected by the VAT

-(6)Intermediate Consumption
+(8)Investment
-(9)VAT effectively paid to the Government
-(10)Other taxes
=(11b)VAT POTENTIAL BASE (VAT_PB)

The potential base for the VAT was calculated for all sectors and defined as VAT_i_PB. The effective implicit VAT rate was calculated for all the sectors as:

VAT_i rate=VAT_i revenues/VAT_i_PB (as in line 11b above); i= sectors 1 to 24.

Following these calculations, we found that the effective implicit overall VAT rate for 1986 resulted equal to 7.9%. The effective rate that prevailed in the most recent

[8] A detailed explanation of the sources of each one of the concepts included in our calculations is presented in section 4 below.

year for which data is available -1994- was 9.1% [9]. Since we believe that the calculated tax data are more reliable than the estimated VAT base, we proceeded to modify the VAT_i_PB calculated with the original IOM figures by defining $VAT1_i\_PB = (7.9/9.1)*VAT_i\_PB$, where 7.9 is the effective implicit overall VAT rate for 1986 from the IOM and 9.1 is the effective implicit overall VAT rate for 1994. This adjustment assures that the overall VAT rate in our data set is consistent with the aggregate 1994 data, but proportional differences at the sectoral level from the IOM are preserved.

Despite the fact that there is a maximum legal rate of VAT in Chile of 18 percent (20 percent in 1986), based on the data in the IOM there were six sectors among our 24 with VAT estimated rates above 18%: Slaughter Houses (100%), Dairy (69.5%), Foods (195.3%), Beverage and Tobacco (118.7%), Textiles (30.8%) and Paper and Printing (35.4%). We regard rates above 18% as implausible and due to imprecise reporting of data to the statistical agencies[10].

Since we consider the calculation of the VAT potential base as the most likely source of the inaccurate reporting (as opposed to the data on collected taxes), we proceeded to increase the VAT potential base (VAT_i_PB) of these six sectors by the amount necessary to reduce the estimated VAT rate of these sectors to 18 percent[11].

Additionally, in order to preserve consistency with the overall effective VAT rate, it was necessary to keep the aggregate figures of VAT_PB equal to the original of the IOM. Thus, we scaled down the VAT_PB of all the other sectors so that the total VAT_PB was unchanged. The scaling was done in an proportional manner where the weights for the sectors were determined by their share of total VAT_PB.

Details of the calculations for the 24 sectors are presented in Annex II.

3. Net indirect tax on final good and services and indirect tax on activities.

We lumped together the IOM data of taxes affecting specific goods and services (Tobacco and Fuels) and taxes affecting activities rather than goods (Real State tax, Licenses, etc.).We called this tax **Production Tax**. The denominator utilized to calculate the tax rate was the Gross Value of Domestic Production at producer prices netted out from the taxes that go into the numerator.

4. Sources and calculations.

What follows is a description of the information contained in Annex II

[9] VAT overall rate=9.1%.: total VAT revenues were 1831.2 millions of Chilean pesos, GDP was 21917.9 millions of Chilean pesos. Sources: Estadisticas de las Finanzas Publicas 1987-1995. Ministerio de Hacienda. Direccion de Presupuestos, p. 77. and Banco Central de Chile, Boletin Mensual # 814, Diciembre 1995, p.3390.

[10] It is also possible that VAT data for a sector in the IOM includes payments from other sectors.

[11] The VAT potential base for the Mining sector was originally negative. We limit the lower bound of the VAT rate to be equal to zero and consequently the VAT rate for the Mining sector was set equal to zero.

The heading *Column #* indicates the referenced column in the Annex II, *Concept* indicates the name of the variable and *Source* identifies what table from the IOM-86 was taken following its own nomenclature[12]. The last column also describes the calculations made in order to get the final results of Table A.I..

Column #	Concept	Source (Tables of IOM-1986)	Own calculations
1	Intermediate Consumption	Pre-Otp. pp.286-291, last row	
2-9	Final transactions	Atp final. p.292.	
10	Imports	Pre-Otp p.285	
11	Investment in Buildings	Atc-inversion. pp. 364-369, row 51	
12	Gross Value of Production Affected by VAT		12=9-6-7
13	Gross Fixed Investment-total	Atc-inversion. pp. 364-375, last row	
14	Activities that generate VAT credit		14=1+13
15	VAT revenues	Pre-Otp. p.285, column 5	
16	Sector shares in total VAT revenues		16=15/total of 15, in %
17	Other indirect taxes (on goods-Tobacco and Fuels)	Pre-Otp. p.285, column 4	
18	VAT-Potential Base		18=12-14-15-17
18b	VAT_PB adjusted to calibrate to 1994 VAT revenues.		18b=18*(7.9 VAT revenues in 1986, as % of GDP)/(9.1 VAT revenues in 1994, as % of GDP)
19	VAT_PB after spreading the negative value of MIN among all the other sectors		19=18b-MIN*18b/(total of column 18b)
20	VAT_PB shares of sectors after excluding those with VAT rate> 20% in column 21 and MIN		20=19/(total of column 19 after excluding seven sectors)
21	VAT implicit rate		20=15/19
22	VAT_PB for those sectors with VAT rate >20 in column 21		22=VAT/0.20
23	Increments in the base for this sectors needed to have them pay 20%.		23=22-19
24	NEW VAT_PB, after subtracting the total of column 23 to the rest of the sectors. The weight used was column 20.		24=19-20*(Total of column 23)
25	Indirect taxes on Tobacco and Fuels	VA row 6.	
26	Other indirect taxes (on activities rather than on goods)	VA row 7	
27	**VAT net rates**		27=(15/24)
28	**Y net rates** (indirect taxes on gross *domestic* production at producer prices)		28=(25+26)/(9-10-25-26)

[12] The IOM information is available to be used in PC. The nomenclature is presented here only to clearly identify the tables used in our calculations. The description of each table could be found in Chapter 5 of the IOM.

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ANNEX I. Tax rates for Chile

The 75 activities of the input-output matrix were aggregated into 24 sectors, as they appeared in Table I in the text.

Classification	Sector # in IOM	ISIC	Description of the sector and mapping to our classification	NET TAX RATES: Indirect tax on Intermediate Consumption	Indirect tax on Production (excluded the Value-Added Tax)	Value Added Tax
Sector in IOM	**1**	1110	Agricultural production, except fruit	**1.42**	**2.72**	**14.04**
Mapped to sector			**WHT and GRO**			
Sector in IOM	**2**	1120	Fruit production	**1.32**	**2.78**	**5.51**
Mapped to sector			**NGC**			
Sector in IOM	**5**	1200	Forestry	**1.68**	**1.28**	**1.15**
Mapped to sector			**FRS**			
Sector in IOM	**6**	1300	Fishing	**2.67**	**0.77**	**5.74**
Mapped to sector			**FSH**			
Sector in IOM	7	2201	Copper	0.05	0.34	0.00
Sector in IOM	8	2202	Iron	1.91	0.38	0.00
Sector in IOM	11	2400	Stone, sand & clay	0.57	0.19	12.20
Sector in IOM	12	2300	Extraction of other minerals	0.78	0.22	0.01
Mapped to sector			**MIN**	**0.28**	**0.31**	**0.22**
Sector in IOM	9	2110	Petroleum & natural gas	0.18	1.44	0.00
Sector in IOM	10	2120	Coal	0.00	1.10	1.60
Sector in IOM	35	3530	Oil refineries	0.01	16.08	30.68
Mapped to sector			**ENR**	**0.03**	**12.14**	**19.75**
Sector in IOM	**13**	3111	Slaughter houses	**0.07**	**0.00**	**87.52**
Mapped to sector			**MEA**			
Sector in IOM	**14**	3112	Dairy products	**0.01**	**0.34**	**54.68**
Mapped to sector			**DAI**			
Sector in IOM	15	3113	Fruit & vegetable canning	0.05	-2.30	48.95
Sector in IOM	16	3114	Fish products	0.03	0.07	3.42
Sector in IOM	17	3115	Manufacture of oil & fat	0.00	0.38	46.84
Sector in IOM	18	3116	Mill & bakery products	0.01	0.40	55.96
Sector in IOM	19	3118	Sugar factories & refineries	0.00	0.37	57.39
Sector in IOM	20	3119	Misc. food products	0.00	0.17	47.03
Sector in IOM	21	3122	Feeds	0.01	0.22	6.81
Mapped to sector			**FOO**	**0.02**	**0.08**	**34.09**
Sector in IOM	22	3133	Soft drinks and beer	0.04	0.59	77.82
Sector in IOM	23	3131	Alcohol beverages	0.06	0.16	70.66
Sector in IOM	24	3140	Tobacco industry	0.03	66.10	27.19
Mapped to sector			**B_T**	**0.05**	**27.58**	**41.21**
Sector in IOM	25	3210	Textile production	0.04	0.59	27.26
Sector in IOM	26	3220	Garment production	0.03	0.49	72.81
Sector in IOM	27	3230	Leather & leather products	0.01	0.55	15.40
Sector in IOM	28	3240	Shoe industry	0.05	0.52	70.63
Mapped to sector			**TEX**	**0.04**	**0.47**	**44.78**
Sector in IOM	29	3310	Wood industry	0.31	0.78	6.24
Sector in IOM	30	3320	Furniture & fixtures	0.06	1.18	10.60
Mapped to sector			**LUM**	**0.21**	**0.92**	**7.55**
Sector in IOM	31	3410	Paper & paper products	0.01	0.55	7.79
Sector in IOM	32	3420	Printing & publishing	0.27	0.93	31.34
Mapped to sector			**PPP**	**0.09**	**0.66**	**14.39**

Classification	Sector # in IOM	ISIC	Description of the sector and mapping to our classification	NET TAX RATES: Indirect tax on Intermediate Consumption	Indirect tax on Production (excluded the Value-Added Tax)	Value Added Tax
Sector in IOM	33	3510	Industrial chemicals	0.00	0.84	3.35
Sector in IOM	34	3520	Other chemical products	0.10	0.61	40.49
Sector in IOM	36	3550	Rubber industry	0.04	0.24	34.45
Sector in IOM	37	3560	Production of plastic products n.e.c.	0.04	0.36	19.40
Sector in IOM	38	3610	Stone and clay products	0.00	-0.91	32.37
Sector in IOM	39	3620	Glass & glass products	0.03	-	18.20
Mapped to sector			**CRP**	**0.06**	**0.54**	**28.07**
Sector in IOM	40	3690	Non-metallic mineral products n.e.c.	0.08	0.89	14.73
Mapped to sector			**NFM**			
Sector in IOM	41	3700	Primary iron and steel manufacturing	0.03	0.79	7.13
Mapped to sector			**I_S**			
Sector in IOM	42	3810	Fabricated metal products	0.05	0.20	17.94
Mapped to sector			**FMP**			
Sector in IOM	43	3820	Non-electric machinery production	0.14	0.52	31.89
Sector in IOM	44	3830	Machinery, equipment & electrical accessories	0.05	0.56	115.40
Sector in IOM	47	3900	Other manufacturing industries	0.10	2.92	117.10
Sector in IOM	46	3850	Professional & scientific equipment	0.00	0.07	191.02
Mapped to sector			**MAC**	**0.08**	**0.73**	**79.22**
Sector in IOM	45	3840	Transport equipment	**0.04**	**-1.30**	**34.24**
Mapped to sector			**TRN**			
Sector in IOM	51	5000	Construction	7.53	2.80	0.51
Sector in IOM	52	6000	Commerce	0.25	2.75	0.09
Sector in IOM	55	7111	Railroad transportation	6.07	-	0.19
Sector in IOM	56	7114	Motor freight cargo transportation	7.01	1.63	1.43
Sector in IOM	57	7112	Passenger road transportation	24.98	1.01	0.00
Sector in IOM	58	7120	Water transportation	0.00	0.60	0.07
Sector in IOM	59	7130	Air transportation	2.06	0.97	0.70
Sector in IOM	60	7190	Transport related services	0.30	1.14	1.86
Sector in IOM	61	7200	Communications	0.00	0.68	13.06
Mapped to sector			**T_T**	**5.19**	**2.16**	**0.91**
Sector in IOM	48	4101	Electric power	0.07	0.41	9.63
Sector in IOM	49	4102	Gas production & distribution	10.88	0.63	41.71
Sector in IOM	50	4200	Hydraulic works & water supply	0.40	-	28.73
Sector in IOM	53	6310	Restaurants	2.95	-	50.70
Sector in IOM	54	6320	Hotels	1.54	1.84	20.35
Sector in IOM	63	8200	Insurance	0.91	1.07	8.29
Sector in IOM	64	8310	Property rental	4.01	3.35	0.32
Sector in IOM	65	8320	Business services	2.99	1.44	2.84
Sector in IOM	66	8900	Real estate	0.84	7.76	0.00
Sector in IOM	67	9311	Public education	15.20	0.95	0.00
Sector in IOM	68	9312	Private education	10.25	1.38	0.00
Sector in IOM	69	9331	Public health	18.81	0.62	0.06
Sector in IOM	70	9332	Private health	12.63	0.80	1.53
Sector in IOM	71	9410	Motion pictures, TV, radio & shows	0.40	3.05	18.60
Sector in IOM	72	9490	Other recreation services	8.99	13.92	6.39

Classification	Sector # in IOM	ISIC	Description of the sector and mapping to our classification	NET TAX RATES: Indirect tax on Intermediate Consumption	Indirect tax on Production (excluded the Value-Added Tax)	Value Added Tax
Sector in IOM	73	9510	Repair services	0.82	1.86	16.34
Sector in IOM	74	9600	Miscellaneous services	5.39	1.95	8.70
Sector in IOM	75	9100	Public Administration & Defense	12.35	0.44	0.00
Mapped to sector			**SER**	**6.17**	**2.23**	**3.08**
Sector in IOM	62	8100	Financial institutions	10.14	2.00	0.97
Mapped to sector			**CGD**			

ANNEX II. Tax Rates for Chile
Data and Calculations

Sector	Intermediate	Final Consumption								Import	K buildings	VBP Domestic	Gross Fixed
	Consumption	Hhold	NGO	Govern-ment	K fijo	Stocks	Exports	Total	Total use	supply, pp	ATC inversion	Affected	Investment
	1	2	3	4	5	6	7	8	9	10	11	12=9-6-7	13
WHT	90005	52671	0	0	2522	1539	10447	67179	199467	13571	3502	187481	12098
GRO	90005	52671	0	0	2522	1539	10447	67179	199467	13571	3502	187481	12098
NGC	33625	22628	0	0	12939	327	60397	96291	113905	2546	2687	53181	19286
WOL	67655	17536	0	0	1910	-1270	4966	23142	140022	618	2653	136326	9242
FRS	4560	595	0	0	2572	-223	7706	10650	22594	128	0	15111	5365
FSH	37364	7550	0	0	0	111	1937	9598	67410	96	0	65362	13448
MIN	272186	6	0	0	0	5421	452396	457823	569091	8683	37794	111274	89785
ENR	183269	85298	0	0	8312	-4880	3477	92207	444172	127278	9921	445575	25354
MEA	101073	114477	0	0	0	242	2902	117621	146471	1309	255	143327	1239
DAI	40582	48701	0	0	0	343	682	49726	62208	2165	133	61183	2492
FOO	309603	223359	0	0	0	16422	113309	353090	479063	22146	5187	349332	17647
B_T	53950	102683	0	0	0	2034	4821	109538	124710	3983	745	117855	2359
TEX	149348	174189	0	0	2528	12728	1970	191415	296338	54947	1335	281640	13626
LUM	46450	17473	0	0	7182	3253	18842	46750	90003	906	329	67908	3909
PP	97608	32283	0	0	0	-529	52421	84175	176132	20308	2752	124240	10387
CRP	146101	91098	0	0	124	9457	10045	110724	408030	160521	2812	388528	8930
NFM	21826	597	0	0	0	1159	136	1892	48487	4387	698	47192	2085
I_S	49957	0	0	0	668	1102	12028	13798	114541	32648	98	101411	3465
FMP	54139	7018	0	0	20290	4062	3295	34665	120232	36875	641	112875	1704
MAC	40262	54810	0	0	139162	5547	2859	202378	324069	254913	218	315663	5362
TRN	25791	19556	0	0	43358	2112	4665	69691	119710	74124	422	112933	1194
T_T	771658	527569	0	0	353277	813	170288	1051947	1736000	83485	20722	1564899	69181
SER	687280	597038	16858	430697	95	0	47822	1092510	1534930	129746	222324	1487108	262355
CGD	37296	21174	0	0	0	0	1272	22446	293249	3378	1378	291977	5520
TOTAL	**3374297**	**2249806**	**16858**	**430697**	**6E+05**	**61309**	**1E+06**	**4E+06**	**8E+06**	**1E+06**	**318730**	**6477885**	**592611**

Sources: I-O Tables-1986. Banco Central Chile.
1. Pre-Otp. pp. 286-291, last row.
7. Pre-Otp. p. 292, column 7th.
9. Pre-Otp. p. 292, column 9th.
11. Atcinversion, pp. 364-369, row 51th.
13. Atcinversion, pp 364-369, last row.
15. Pre-Otp. p. 285, column 5th.
17. Pre-Otp. p. 285, column 4th.

Sector	IC + GFI that generates VAT credit	VAT Revenues	VAT	Other taxes	VAT-Potential Base	VAT-Potential Base adjusted by 7.9/9.1	VAT-Potential Base	VAT-Potential Base	VAT implicit net rate	New Base if VAT rate>18%	Base corrections
	14=1+13	15	16	17	18=12-14-15-17	18b=18*7.9.9.1	19=18b+share*MIN	20	21=15/19	22=VAT/0.18	23=22-19
			Shares					Shares			
WHT	77907	11835	7.55%	0	97739	84421	82767	2.84%	14.0%		
GRO	77907	11835	7.55%	0	97739	84421	82767	2.84%	14.0%		
NGC	14339	4098	2.61%	0	34744	30010	29422	1.01%	13.7%		
WOL	58413	2015	1.29%	0	75898	65556	64272	2.20%	3.1%		
FRS	-805	204	0.13%	0	15712	13571	13305	0.46%	1.5%		
FSH	23916	1919	1.22%	0	39527	34141	33472	1.15%	5.6%		
MIN	182401	634	0.00%	0	-71761	-61983	0	0.00%	0.0%		
ENR	157915	22916	14.62%	35808	228936	197740	193868	6.65%	11.6%		
MEA	99834	20203	0.00%	0	23290	20116	19722	0.00%	100.4%	112239	92516
DAI	38090	8665	0.00%	0	14428	12462	12218	0.00%	69.5%	48139	35921
FOO	291956	36019	0.00%	0	21357	18447	18086	0.00%	195.3%	200106	182020
B_T	51591	19511	0.00%	27729	19024	16432	16110	0.00%	118.7%	108394	92285
TEX	135722	30694	0.00%	0	115224	99523	97574	0.00%	30.8%	170522	72948
LUM	42541	2936	1.87%	0	22431	20024	19632	0.67%	14.7%		
PP	87221	8664	0.00%	0	28355	24491	24012	0.00%	35.4%	48133	24122
CRP	137171	22803	14.54%	0	228554	197410	193544	6.64%	11.6%		
NFM	19741	3027	1.93%	0	24424	21096	20683	0.71%	14.3%		
I_S	46492	2267	1.45%	0	52652	45477	44587	1.53%	5.0%		
FMP	52435	4527	2.89%	0	55913	48294	47348	1.62%	9.4%		
MAC	34900	18958	12.09%	0	261805	226130	221702	7.60%	8.4%		
TRN	24597	5699	3.64%	0	82637	71377	69979	2.40%	8.0%		
T_T	702477	16857	10.75%	0	845565	730345	716042	24.56%	2.3%		
SER	424925	24880	15.87%	0	1278308	1104121	1082498	37.12%	2.3%		
CGD	31776	2417	1.54%	0	257784	222657	218297	7.49%	1.1%		
TOTAL	**2781686**	**3E+05**	**2E+05**	**####**	**3592501**	3102973	**3103610.662**	**2915889.1**	**9.1%**	**687533**	**499812**

Sourcees:
1. Pre-Ot
7. Pre-Ot
9. Pre-Ot
11. Atci
13. Atci
15. Pre-O
17. Pre-O

Sector	New Base 24=19 share*Tot23	New share	Indirect taxes (Tobacco and Fuels) 25	Other indirect taxes 26	VAT net rates 27=15/24	TY Indirect taxes/ on gross production 29=(25+26)/(9-25-26)
WHT	68580		0	4745	17.3%	2.7%
GRO	68580		0	4745	17.3%	2.7%
NGC	24379		0	3019	16.8%	2.8%
WOL	53255		0	884	3.8%	0.6%
FRS	11025		0	283	1.9%	1.3%
FSH	27735		0	597	6.9%	0.8%
MIN	0		0	1726	0.0%	0.3%
ENR	160637		35808	962	14.3%	12.1%
MEA	112239		0	-89	18.0%	-0.1%
DAI	48139		0	170	18.0%	0.3%
FOO	200106		0	207	18.0%	0.1%
B_T	108394		27729	350	18.0%	27.6%
TEX	170522		0	1021	18.0%	0.5%
LUM	16267		0	792	18.0%	0.9%
PP	48133		0	1063	18.0%	0.7%
CRP	160369		0	385	14.2%	0.5%
NFM	17138		0	393	17.7%	0.9%
I_S	36944		0	421	6.1%	0.8%
FMP	39232		0	143	11.5%	0.2%
MAC	183700		0	318	10.3%	0.7%
TRN	57984		0	-647	9.8%	-1.3%
T_T	593305		0	35044	2.8%	2.2%
SER	896947		0	37826	2.8%	2.2%
CGD	180879		0	5719	1.3%	2.2%
TOTAL	**3103611**		**63537**	**89613**	**9.1%**	**2.4%**

1. Pre-Ot
7. Pre-Ot
9. Pre-Ot
11. Atci
13. Atci
15. Pre-O
17. Pre-O

Appendix B

Overview of Tariff Calculations for the Quantitative Analysis of Chile's Trade Policy Options

Ulrich Reincke
The World Bank

0. Introduction

This document provides an overview over the tariff aggregation for the project evaluation Chile's trade policy options. Section 1 presents the data source, section 2 discusses the data aggregation method and section 3 lists the Mercosur tariff matrices.

1. Data and Data Sources:

The computations are based on trade and tariff data from the Trade Analysis and Information Database (TRAINS 2.0 A) from February 1996. This data has been assembled and stored on CD-ROM by the United Nations Conference on Trade and Development (UNCTAD). TRAINS data for Argentina, Brazil, and Chile were used. The trade data are from the year 1994 and tariff data are from 1995. For the other countries in the project, the GTAP database was employed for the tariff data.

2. Calculation of the Tariff Matrices

For each import market a tariff matrix was generated, that lists the trade weighted average tariff rates faced by the 30 supplying regions (columns) in the 32 product categories (rows). Let the index i run over the 32 product categories (i.e. grains, non-grain crops, wool...) and let the index j run over the 20 supplying regions (i.e. Australia, New Zealand, Japan ...). The entries of each tariff matrix $t_{i,j}$ were computed according to the following formula:

$$t_{i,j} = \frac{\sum_{e \in EXPG_j} \sum_{i_k \in PROD_i} T_{i_k} w_{i_k}^e}{\sum_{e \in EXPG_j} \sum_{i_k \in PROD_i} w_{i_k}^e}$$

where T_{i_k} is the tariff rate in tariff line i_k, $w_{i_k}^e$ is the value of trade imports originating in exporter *e*, $EXPG_j$ is the exporter group *j*, and $PROD_i$ is the product group *i*. The detailed exporter and product groups are listed in Table 1. and Table 2. Please notice that the first summation in the numerator and denominator is necessary since

some regions for example Sub-Saharan Africa or Eastern Europe are aggregates of several exporter countries. Needless to say that for regions of one country, (for example Japan) the first summation is not necessary.

To get a better grasp of the structure of the tariff matrices let us look next at Argentina's tariff matrix for the most favored nation tariff rates (arg_mfn.txt). In column 1, row 4 we find the coefficient $t_{1,4} = 0.2$ which is the trade weighted average MFN tariff rate for Australia's "non grain crops" exports as they enter Argentina. In column 2 row 4 in contrast we find the coefficient $t_{2,4} = 8.7$ which is the trade weighted average MFN tariff rate for New Zealand's "non grain crops" exports as they enter Argentina.

The two exporter countries face different weighted average tariff rates, since they ship different bundles of goods in the category "non grain crops" to Argentina. On average Australia exports more low tariff products, than New Zealand. As an illustration a hypothetical example for the product category "non grain crops" will be provided:

> Let us assume New Zealand exports \$1mill of potatos and \$2mill of mushrooms to Argentina, while Australia exports \$ 2 mill of potatoes and \$ 1 mill of mushrooms to Argentina. Potatoes and mushrooms are presumed to be the only "non grain crop" products that both countries export to Argentina. Furthermore let Argentina have an ad valorem tariff rate of 2% in potatoes and 10% on mushrooms. Then Argentina's weighted average tariff rate on New Zealand's "non grain crop" exports is
>
> $$t_{1,4} = \frac{2\% \cdot 1\ \$\ \text{mill} + 10\% \cdot 2\ \$\ \text{mill}}{1\ \$\ \text{mill} + 2\ \$\ \text{mill}} = \frac{22\%}{3} = 7.33\% \ ,$$
>
> and on Australia's "non grain crop" exports is
>
> $$t_{2,4} = \frac{2\% \cdot 2\ \$\ \text{mill} + 10\% \cdot 1\ \$\ \text{mill}}{1\ \$\ \text{mill} + 2\ \$\ \text{mill}} = \frac{14\%}{3} = 4.67\% \ .$$
>
> Hence although Argentina's MFN tariff schedule does not discriminate against products that originate in different countries, the actual tariff incidence falls heavier those countries, that export relatively more high tariff products.

In some export regions there was no trade in certain product categories and consequently a weighted average tariff could not be calculated. A tariff rate of -1 marks missing tariff averages. However, missing tariff averages were substituted by the average tariff of imports from the world as a whole. So one will either find an entire row of -1 or no -1 at all. This procedure was followed when in the construction of the original GTAP version 2 and version 3 matrices.

The matrices show in their header the acronym of the importing market and the type of tariff rate used for the calculation:

- ARG:= Argentina,
- BRA:= Brazil,
- CHL:= Chile,
- MFN:= Applied Most Favored Nation Tariff,
- CET:= Mercosur Common External Tariff.

The above procedure was applied to calculate the following tariff matrices:

- arg_mfn.txt (Argentina, Applied Most Favored Nation Tariff)
- arg_cet.txt (Argentina, Mercosur Common External Tariff)
- bra_mfn.txt (Brazil, Applied Most Favored Nation Tariff)
- bra_cet.txt (Brazil, Mercosur Common External Tariff)
- chl_mfn.txt (Chile, Applied Most Favored Nation Tariff)

Each tariff matrix lists in the rows the products and in the columns the exporting markets. The columns and row order follow the region and product numbering of table B.1 and B.2. The five tariff matrices are listed in section 3.

The detailed GTAP regions and sectors are mapped into our 24-sector aggregation in the obvious way. The aggregate EU in our model includes the E_U in the original GTAP model and the EU3 of the original GTAP model. All other regions are aggregated into our Residual ROW region. With respect to sector aggregation, PDR and GRO are aggregated into GRO, WOL and OLP into WOL; COL, OIL, GAS and P_C into ENR; OMN and NMM into MIN; OFP and PCR into FOO; TEX, WAP and LEA into TEX; OME and OMF into MAC; and EGW, CNS, OSP, OSG and DWE into SER.

We then calculate average MFN tariffs for each of CHL, ARG and BRA with respect to all other regions. In other words, these averages are unweighted with respect to base level trade flows between CHL, ARG and BRA and the other regions. However, we do keep distinct the tariffs that each apply against all other regions. We do likewise for the CET tariffs imposed by ARG and BRA.

In the initial benchmark equilibrium each of CHL, ARG and BRA are assumed to have the MFN tariffs calculated as described above. We then simulate the completion of MERCOSUR by assuming that ARG and BRA adopt the CET tariffs calculated as above. The solution to *this* simulation is then adopted as our "reference equilibrium" for all further simulations.

Our base model uses the MFN tariffs for Chile, and a simple average of the CET of ARG and BRA as the CET used by Chile when it forms a full customs union with MERCOSUR in simulation CHL_M.

Table B.1. Export Market Aggregation: Version 3 of the GTAP Data Base

1	AUS	Australia
2	NZL	New Zealand
3	JPN	Japan
4	KOR	Korea
5	IDN	Indonesia
6	MYS	Malaysia
7	PHL	Philippines
8	SGP	Singapore
9	THA	Thailand
10	CHN	China
11	HKG	Hong Kong
12	TWN	Taiwan
13	IDI	India
14	RAS	Rest of South Asia (composite region) (includes: Bangladesh, Bhutan, Maldives, Nepal, Pakistan, Sri Lanka)
15	CAN	Canada
16	USA	United States
17	MEX	Mexico
18	CAM	Central America and the Carribean (composite region) (includes: Antigua & Barbuda, Bahamas, Barbados, Belize, Costa Rica, Cuba, Dominica, Dominican Republic, El Salvador, Grenada, Guatemala, Haiti, Honduras, Jamaica, Nicaragua, Panama, St. Kitts & Nevis, St. Lucia, St. Vincent, Trinidad & Tobago)
19	ARG	Argentina
20	BRA	Brazil
21	CHL	Chile
22	RSM	Rest of South America (composite region) (includes: Bolivia, Colombia, Ecuador, Guyana, Paraguay, Peru, Suriname, Uruguay, Venezuela)
23	E_U	European Union 12 (includes: Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, United Kingdom)
24	EU3	Austria, Finland, and Sweden
25	EFT	EFTA (composite region) (includes Iceland, Norway, Switzerland)
26	CEA	Central European Associates (composite region) (includes: Bulgaria, Czech Republic, Hungary Poland, Romania, Slovakia, Slovenia)
27	FSU	Former Soviet Union (includes: Armenia, Azerbaijan, Belarus, Estonia, Georgia, Kazakhstan, Kyrgyz Republic, Latvia, Lithuania, Moldova, Russian Federation, Tajikistan, Turkmenistan Ukraine, Uzbekistan)
28	MEA	Middle East and North Africa (composite region) (includes: Algeria, Bahrain, Egypt, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Qatar, Saudi Arabia, Syrian Arab Republic, Tunisia, United Arab Emirates, Yemen Arab Republic)
29	SSA	Sub Saharan Africa (composite region) (includes: Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo, Cote d'Ivoire, Djibouti, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, Sao Tome & Principe, Senegal, Seychelles Islands, Sierra Leone, Somalia, South Africa, Sudan, Swaziland, Tanzania, Togo, Uganda, Zaire, Zambia, Zimbabwe)

```
30 ROW Rest of World (composite region) (includes:
               Afghanistan, Albania, Andorra, Bosnia-
               Herzegovina, Brunei,  Cambodia, Croatia,
               Cyprus, Fiji, Kiribati, Laos, Leichtenstein,
               Macedonia [former Yugoslav Republic of],
               Malta, Monaco, Mongolia, Myanmar, Nauru,
               North Korea, Papua New Guinea, San Marino,
               Solomon Islands, Tonga, Turkey, Tuvalu,
               Vanuatu, Viet Nam, Western Samoa, Yugoslavia
               [Serbia and Montenegro])
```

Table B.2. GTAP Product Categories: Version 3 of the Data Base

```
1  pdr, paddy rice
2  wht, wheat
3  gro, grains
4  ngc, non grain crops
5  wol, wool
6  olp, other livestock
7  for, forestry
8  fsh, fisheries
9  col, coal
10 oil, oil
11 gas, gas
12 omn, other minerals
13 pcr, processed rice
14 met, meat products
15 mil, milk products
16 ofp, other food products
17 b_t, beverages and tobacco
18 tex, textiles
19 wap, wearing apparels
20 lea, leather etc
21 lum, lumber
22 ppp, pulp paper etc
23 p_c, petroleum and coal
24 crp, chemicals rubbers and plastics
25 nmm, nonmetallic minerals
26 i_s, primary ferrous metals
27 nfm, nonferrous metals
28 fmp, fabricated metal products
29 trn, transport industries
30 ome, machinery and equipment
31 omf, other manufacturing
32 egw, electricity water and gas
```

3. Tariff Matrices: agr_mfn, agr_cet, bra_mfn, bra_cet, chl_mfn

```
32 30 ROW_ORDER header ", ARG_MFN
   6.7   6.7   6.7   6.7   6.7   6.7   6.7   6.7   6.7   6.7   6.7   6.7   6.7   6.7   6.7   7.1   6.7   6.7   6.7   6.7   6.7   6.7   6.7   6.7   6.7   6.7   6.7   6.7   6.7   6.7
   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0
   0.4   0.4   0.4   0.4   0.4   0.4   0.4   0.4   0.4   0.4   0.4   0.4   0.4   0.4   0.4   0.4   0.4   0.4   0.4   0.2   0.0   7.5   0.0   0.4   0.4   0.4   0.4   0.0   0.0   0.4
   0.2   8.7   0.5   8.0   4.4   4.0   4.0   4.6   3.7   6.9   7.9   1.7   6.7   7.6   2.3   3.6   6.2   9.9   8.8   9.9   8.2   9.6   6.3   8.0   8.0   8.0   6.0   7.5   5.2   9.7
   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0
   2.1   4.0   2.3   2.3   2.0   2.3   2.3   2.3   2.3   8.0   2.3   2.3   2.3   2.3   0.5   1.3   2.3   2.8   2.3   1.2   2.5   3.1   1.8   2.3   6.8   2.3   2.3   2.0   6.7   2.3
   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0
  10.0   8.6   8.6  10.0  10.0  10.0   8.0   8.6   8.6   8.6   8.6   8.6  10.0   8.6   6.1   8.6   8.6   8.6   9.3  10.0   9.5   8.6   8.6   8.6   8.6   8.6  10.0   8.6   8.6   8.6
   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
   2.8   4.0   2.3   2.3   2.3   2.3   2.3   2.3   2.3   2.5   2.3  10.0   2.3   2.3   1.2   3.3   4.0   4.2   2.3   2.1   2.2   2.9   4.5   3.5   5.3   2.3   4.0   2.3   3.1   2.3
  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0
  10.5  16.0  16.0  10.5  10.5  10.5  10.5  10.5  10.5  10.5  10.5  10.5  10.5  10.5  10.0  10.3  10.5  10.5  12.5  10.7   9.9  10.5  10.6   9.9  10.5  10.0  10.5  10.5  10.5  10.5
  15.4  15.4  15.4  15.4  15.4  15.4  15.4  15.4  15.4  15.4  15.4  15.4  15.4  15.4  15.4  15.4  15.4  15.4  15.4  15.4  15.4  15.4  15.4  15.4  15.4  15.4  15.4  15.4  15.4  15.4
  15.2  15.2  15.2  15.2  15.2  15.2  15.2  15.2  15.2  15.2  15.2  15.2  15.2  15.2  15.2  15.2  15.2  15.2  15.2  15.2  15.2  15.2  15.2  15.2  15.2  15.2  15.2  15.2  15.2  15.2
  17.9  17.9  17.9  17.9  17.9  17.9  17.9  17.9  17.9  17.9  17.9  17.9  17.9  17.9  17.9  17.9  17.9  17.9  17.9  17.9  17.9  17.9  17.9  17.9  17.9  17.9  17.9  17.9  17.9  17.9
  17.5  17.5  17.5  17.5  17.5  17.5  17.5  17.5  17.5  17.5  17.5  17.5  17.5  17.5  17.5  17.5  17.5  17.5  17.5  17.5  17.5  17.5  17.5  17.5  17.5  17.5  17.5  17.5  17.5  17.5
  21.5  21.5  21.5  21.5  21.5  21.5  21.5  21.5  21.5  21.5  21.5  21.5  21.5  21.5  21.5  21.5  21.5  21.5  21.5  21.5  21.5  21.5  21.5  21.5  21.5  21.5  21.5  21.5  21.5  21.5
  24.9  24.9  24.9  24.9  24.9  24.9  24.9  24.9  24.9  24.9  24.9  24.9  24.9  24.9  24.9  24.9  24.9  24.9  24.9  24.9  24.9  24.9  24.9  24.9  24.9  24.9  24.9  24.9  24.9  24.9
  13.5  13.5  13.5  13.5  13.5  13.5  13.5  13.5  13.5  13.5  13.5  13.5  13.5  13.5  13.5  13.5  13.5  13.5  13.5  13.5  13.5  13.5  13.5  13.5  13.5  13.5  13.5  13.5  13.5  13.5
  15.3  15.3  15.3  15.3  15.3  15.3  15.3  15.3  15.3  15.3  15.3  15.3  15.3  15.3  15.3  15.3  15.3  15.3  15.3  15.3  15.3  15.3  15.3  15.3  15.3  15.3  15.3  15.3  15.3  15.3
   0.7   0.7   0.7   0.7   0.7   0.7   0.7   0.7   0.7   0.7   0.7   0.7   0.7   0.7   0.7   0.7   0.7   0.7   0.7   0.7   0.7   0.7   0.7   0.7   0.7   0.7   0.7   0.7   0.7   0.7
  10.3  10.3  10.3  10.3  10.3  10.3  10.3  10.3  10.3  10.3  10.3  10.3  10.3  10.3  10.3  10.3  10.3  10.3  10.3  10.3  10.3  10.3  10.3  10.3  10.3  10.3  10.3  10.3  10.3  10.3
  12.7  12.7  12.7  12.7  12.7  12.7  12.7  12.7  12.7  12.7  12.7  12.7  12.7  12.7  12.7  12.7  12.7  12.7  12.7  12.7  12.7  12.7  12.7  12.7  12.7  12.7  12.7  12.7  12.7  12.7
  15.2  15.2  15.2  15.2  15.2  15.2  15.2  15.2  15.2  15.2  15.2  15.2  15.2  15.2  15.2  15.2  15.2  15.2  15.2  15.2  15.2  15.2  15.2  15.2  15.2  15.2  15.2  15.2  15.2  15.2
   9.0   9.0   9.0   9.0   9.0   9.0   9.0   9.0   9.0   9.0   9.0   9.0   9.0   9.0   9.0   9.0   9.0   9.0   9.0   9.0   9.0   9.0   9.0   9.0   9.0   9.0   9.0   9.0   9.0   9.0
  16.8  16.8  16.8  16.8  16.8  16.8  16.8  16.8  16.8  16.8  16.8  16.8  16.8  16.8  16.8  16.8  16.8  16.8  16.8  16.8  16.8  16.8  16.8  16.8  16.8  16.8  16.8  16.8  16.8  16.8
  16.9  16.9  16.9  16.9  16.9  16.9  16.9  16.9  16.9  16.9  16.9  16.9  16.9  16.9  16.9  16.9  16.9  16.9  16.9  16.9  16.9  16.9  16.9  16.9  16.9  16.9  16.9  16.9  16.9  16.9
   9.3   9.3   9.3   9.3   9.3   9.3   9.3   9.3   9.3   9.3   9.3   9.3   9.3   9.3   9.3   9.3   9.3   9.3   9.3   9.3   9.3   9.3   9.3   9.3   9.3   9.3   9.3   9.3   9.3   9.3
  18.9  18.9  18.9  18.9  18.9  18.9  18.9  18.9  18.9  18.9  18.9  18.9  18.9  18.9  18.9  18.9  18.9  18.9  18.9  18.9  18.9  18.9  18.9  18.9  18.9  18.9  18.9  18.9  18.9  18.9
   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
```

```
32 30 ROW_ORDER header ", ARG_CET
   6.7   6.7   6.7   6.7   6.7   6.7   6.7   6.7   6.7   6.7   6.7   6.7   6.7   6.7   6.7   7.1   6.7   6.7   6.7   6.7   6.7   6.7   6.7   6.7   6.7   6.7   6.7   6.7   6.7   6.7
   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0
   0.4   0.4   0.4   0.4   0.4   0.4   0.4   0.4   0.4   0.4   0.4   0.4   0.4   0.4   0.4   0.4   0.4   0.4   0.4   0.2   0.0   7.5   0.0   0.4   0.4   0.4   0.4   0.0   0.0   0.4
   0.2   8.7   0.5   8.0   4.4   4.0   4.0   4.6   3.7   6.9   7.9   1.7   6.7   7.6   2.3   3.6   6.2   9.9   8.8   9.9   8.2   9.6   6.3   8.0   8.0   8.0   6.0   7.5   5.2   9.7
   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0
   2.1   4.0   2.3   2.3   2.0   2.3   2.3   2.3   2.3   8.0   2.3   2.3   2.3   2.3   0.5   1.3   2.3   2.8   2.3   1.2   2.5   3.1   1.8   2.3   6.8   2.3   2.3   2.0   6.7   2.3
   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0
  10.0   8.6   8.6  10.0  10.0  10.0   8.0   8.6   8.6   8.6   8.6   8.6  10.0   8.6   6.1   8.6   8.6   8.6   9.3  10.0   9.5   8.6   8.6   8.6   8.6   8.6  10.0   8.6   8.6   8.6
   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
   2.8   4.0   2.3   2.3   2.3   2.3   2.3   2.3   2.3   2.5   2.3  10.0   2.3   2.3   1.2   3.3   4.0   4.2   2.3   2.1   2.2   2.9   4.5   3.5   5.3   2.3   4.0   2.3   3.1   2.3
  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0
  10.5  16.0  16.0  10.5  10.5  10.5  10.5  10.5  10.5  10.5  10.5  10.5  10.5  10.5  10.0  10.3  10.5  10.5  12.5  10.7   9.9  10.5  10.6   9.9  10.5  10.0  10.5  10.5  10.5  10.5
  15.4  15.4  15.4  15.4  15.4  15.4  15.4  15.4  15.4  15.4  15.4  15.4  15.4  15.4  15.4  15.4  15.4  15.4  15.4  15.4  15.4  15.4  15.4  15.4  15.4  15.4  15.4  15.4  15.4  15.4
  15.0  15.0  15.0  15.0  15.0  15.0  15.0  15.0  15.0  15.0  15.0  15.0  15.0  15.0  15.0  15.0  15.0  15.0  15.0  15.0  15.0  15.0  15.0  15.0  15.0  15.0  15.0  15.0  15.0  15.0
  19.1  19.1  19.1  19.1  19.1  19.1  19.1  19.1  19.1  19.1  19.1  19.1  19.1  19.1  19.1  19.1  19.1  19.1  19.1  19.1  19.1  19.1  19.1  19.1  19.1  19.1  19.1  19.1  19.1  19.1
  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7
  19.6  19.6  19.6  19.6  19.6  19.6  19.6  19.6  19.6  19.6  19.6  19.6  19.6  19.6  19.6  19.6  19.6  19.6  19.6  19.6  19.6  19.6  19.6  19.6  19.6  19.6  19.6  19.6  19.6  19.6
  19.4  19.4  19.4  19.4  19.4  19.4  19.4  19.4  19.4  19.4  19.4  19.4  19.4  19.4  19.4  19.4  19.4  19.4  19.4  19.4  19.4  19.4  19.4  19.4  19.4  19.4  19.4  19.4  19.4  19.4
  11.8  11.8  11.8  11.8  11.8  11.8  11.8  11.8  11.8  11.8  11.8  11.8  11.8  11.8  11.8  11.8  11.8  11.8  11.8  11.8  11.8  11.8  11.8  11.8  11.8  11.8  11.8  11.8  11.8  11.8
  10.4  10.4  10.4  10.4  10.4  10.4  10.4  10.4  10.4  10.4  10.4  10.4  10.4  10.4  10.4  10.4  10.4  10.4  10.4  10.4  10.4  10.4  10.4  10.4  10.4  10.4  10.4  10.4  10.4  10.4
   0.7   0.7   0.7   0.7   0.7   0.7   0.7   0.7   0.7   0.7   0.7   0.7   0.7   0.7   0.7   0.7   0.7   0.7   0.7   0.7   0.7   0.7   0.7   0.7   0.7   0.7   0.7   0.7   0.7   0.7
  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6
  12.6  12.6  12.6  12.6  12.6  12.6  12.6  12.6  12.6  12.6  12.6  12.6  12.6  12.6  12.6  12.6  12.6  12.6  12.6  12.6  12.6  12.6  12.6  12.6  12.6  12.6  12.6  12.6  12.6  12.6
  11.4  11.4  11.4  11.4  11.4  11.4  11.4  11.4  11.4  11.4  11.4  11.4  11.4  11.4  11.4  11.4  11.4  11.4  11.4  11.4  11.4  11.4  11.4  11.4  11.4  11.4  11.4  11.4  11.4  11.4
   7.7   7.7   7.7   7.7   7.7   7.7   7.7   7.7   7.7   7.7   7.7   7.7   7.7   7.7   7.7   7.7   7.7   7.7   7.7   7.7   7.7   7.7   7.7   7.7   7.7   7.7   7.7   7.7   7.7   7.7
  16.5  16.5  16.5  16.5  16.5  16.5  16.5  16.5  16.5  16.5  16.5  16.5  16.5  16.5  16.5  16.5  16.5  16.5  16.5  16.5  16.5  16.5  16.5  16.5  16.5  16.5  16.5  16.5  16.5  16.5
  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1
  12.9  12.9  12.9  12.9  12.9  12.9  12.9  12.9  12.9  12.9  12.9  12.9  12.9  12.9  12.9  12.9  12.9  12.9  12.9  12.9  12.9  12.9  12.9  12.9  12.9  12.9  12.9  12.9  12.9  12.9
  18.0  18.0  18.0  18.0  18.0  18.0  18.0  18.0  18.0  18.0  18.0  18.0  18.0  18.0  18.0  18.0  18.0  18.0  18.0  18.0  18.0  18.0  18.0  18.0  18.0  18.0  18.0  18.0  18.0  18.0
   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
```

```
32 30 ROW_ORDER header ", bra_MFN
   7.9   7.9   7.9   7.9   7.9   7.9   7.9   7.9   7.9   7.9   7.9   7.9   7.9   7.9   7.9   7.9   7.9   7.9   7.9   7.9   7.9   7.9   7.9   7.9   7.9   7.9   7.9   7.9   7.9   7.9
   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0
   7.4   7.4   7.4   7.4   7.4   7.4   7.4   7.4   7.4   7.4   7.4   7.4   7.4   7.4   7.4   7.4   7.4   7.4   7.4   7.4   7.4   7.4   7.4   7.4   7.4   7.4   7.4   7.4   7.4   7.4
   4.4   4.4   4.4   4.4   4.4   4.4   4.4   4.4   4.4   4.4   4.4   4.4   4.4   4.4   4.4   4.4   4.4   4.4   4.4   4.4   4.4   4.4   4.4   4.4   4.4   4.4   4.4   4.4   4.4   4.4
   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0
   2.4   2.4   2.4   2.4   2.4   2.4   2.4   2.4   2.4   2.4   2.4   2.4   2.4   2.4   2.4   2.4   2.4   2.4   2.4   2.4   2.4   2.4   2.4   2.4   2.4   2.4   2.4   2.4   2.4   2.4
   2.1   2.1   2.1   2.1   2.1   2.1   2.1   2.1   2.1   2.1   2.1   2.1   2.1   2.1   2.1   2.1   2.1   2.1   2.1   2.1   2.1   2.1   2.1   2.1   2.1   2.1   2.1   2.1   2.1   2.1
   9.9   9.9   9.9   9.9   9.9   9.9   9.9   9.9   9.9   9.9   9.9   9.9   9.9   9.9   9.9   9.9   9.9   9.9   9.9   9.9   9.9   9.9   9.9   9.9   9.9   9.9   9.9   9.9   9.9   9.9
   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
   8.5   8.5   8.5   8.5   8.5   8.5   8.5   8.5   8.5   8.5   8.5   8.5   8.5   8.5   8.5   8.5   8.5   8.5   8.5   8.5   8.5   8.5   8.5   8.5   8.5   8.5   8.5   8.5   8.5   8.5
  10.1  10.1  10.1  10.1  10.1  10.1  10.1  10.1  10.1  10.1  10.1  10.1  10.1  10.1  10.1  10.1  10.1  10.1  10.1  10.1  10.1  10.1  10.1  10.1  10.1  10.1  10.1  10.1  10.1  10.1
   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0
  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0
  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7
  22.9  22.9  22.9  22.9  22.9  22.9  22.9  22.9  22.9  22.9  22.9  22.9  22.9  22.9  22.9  22.9  22.9  22.9  22.9  22.9  22.9  22.9  22.9  22.9  22.9  22.9  22.9  22.9  22.9  22.9
  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2
  12.6  12.6  12.6  12.6  12.6  12.6  12.6  12.6  12.6  12.6  12.6  12.6  12.6  12.6  12.6  12.6  12.6  12.6  12.6  12.6  12.6  12.6  12.6  12.6  12.6  12.6  12.6  12.6  12.6  12.6
  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2
  19.5  19.5  19.5  19.5  19.5  19.5  19.5  19.5  19.5  19.5  19.5  19.5  19.5  19.5  19.5  19.5  19.5  19.5  19.5  19.5  19.5  19.5  19.5  19.5  19.5  19.5  19.5  19.5  19.5  19.5
  11.3  11.3  11.3  11.3  11.3  11.3  11.3  11.3  11.3  11.3  11.3  11.3  11.3  11.3  11.3  11.3  11.3  11.3  11.3  11.3  11.3  11.3  11.3  11.3  11.3  11.3  11.3  11.3  11.3  11.3
  11.1  11.1  11.1  11.1  11.1  11.1  11.1  11.1  11.1  11.1  11.1  11.1  11.1  11.1  11.1  11.1  11.1  11.1  11.1  11.1  11.1  11.1  11.1  11.1  11.1  11.1  11.1  11.1  11.1  11.1
   7.8   7.8   7.8   7.8   7.8   7.8   7.8   7.8   7.8   7.8   7.8   7.8   7.8   7.8   7.8   7.8   7.8   7.8   7.8   7.8   7.8   7.8   7.8   7.8   7.8   7.8   7.8   7.8   7.8   7.8
  13.1  13.1  13.1  13.1  13.1  13.1  13.1  13.1  13.1  13.1  13.1  13.1  13.1  13.1  13.1  13.1  13.1  13.1  13.1  13.1  13.1  13.1  13.1  13.1  13.1  13.1  13.1  13.1  13.1  13.1
   8.2   8.2   8.2   8.2   8.2   8.2   8.2   8.2   8.2   8.2   8.2   8.2   8.2   8.2   8.2   8.2   8.2   8.2   8.2   8.2   8.2   8.2   8.2   8.2   8.2   8.2   8.2   8.2   8.2   8.2
  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2
  12.2  12.2  12.2  12.2  12.2  12.2  12.2  12.2  12.2  12.2  12.2  12.2  12.2  12.2  12.2  12.2  12.2  12.2  12.2  12.2  12.2  12.2  12.2  12.2  12.2  12.2  12.2  12.2  12.2  12.2
   6.8   6.8   6.8   6.8   6.8   6.8   6.8   6.8   6.8   6.8   6.8   6.8   6.8   6.8   6.8   6.8   6.8   6.8   6.8   6.8   6.8   6.8   6.8   6.8   6.8   6.8   6.8   6.8   6.8   6.8
  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2
  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7
  15.6  15.6  15.6  15.6  15.6  15.6  15.6  15.6  15.6  15.6  15.6  15.6  15.6  15.6  15.6  15.6  15.6  15.6  15.6  15.6  15.6  15.6  15.6  15.6  15.6  15.6  15.6  15.6  15.6  15.6
  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7
   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0

32 30 ROW_ORDER header ", bra_CET
   7.9   7.9   7.9   7.9   7.9   7.9   7.9   7.9   7.9   7.9   7.9   7.9   7.9   7.9   7.9   7.9   7.9   7.9   7.9   7.9   7.9   7.9   7.9   7.9   7.9   7.9   7.9   7.9   7.9   7.9
   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0   5.0
   7.6   7.6   7.6   7.6   7.6   7.6   7.6   7.6   7.6   7.6   7.6   7.6   7.6   7.6   7.6   7.6   7.6   7.6   7.6   7.6   7.6   7.6   7.6   7.6   7.6   7.6   7.6   7.6   7.6   7.6
   6.2   6.2   6.2   6.2   6.2   6.2   6.2   6.2   6.2   6.2   6.2   6.2   6.2   6.2   6.2   6.2   6.2   6.2   6.2   6.2   6.2   6.2   6.2   6.2   6.2   6.2   6.2   6.2   6.2   6.2
   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0   8.0
   2.5   2.5   2.5   2.5   2.5   2.5   2.5   2.5   2.5   2.5   2.5   2.5   2.5   2.5   2.5   2.5   2.5   2.5   2.5   2.5   2.5   2.5   2.5   2.5   2.5   2.5   2.5   2.5   2.5   2.5
   2.1   2.1   2.1   2.1   2.1   2.1   2.1   2.1   2.1   2.1   2.1   2.1   2.1   2.1   2.1   2.1   2.1   2.1   2.1   2.1   2.1   2.1   2.1   2.1   2.1   2.1   2.1   2.1   2.1   2.1
   9.9   9.9   9.9   9.9   9.9   9.9   9.9   9.9   9.9   9.9   9.9   9.9   9.9   9.9   9.9   9.9   9.9   9.9   9.9   9.9   9.9   9.9   9.9   9.9   9.9   9.9   9.9   9.9   9.9   9.9
   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0   2.0
  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0
  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7
  15.9  15.9  15.9  15.9  15.9  15.9  15.9  15.9  15.9  15.9  15.9  15.9  15.9  15.9  15.9  15.9  15.9  15.9  15.9  15.9  15.9  15.9  15.9  15.9  15.9  15.9  15.9  15.9  15.9  15.9
  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2  10.2
  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1
  16.8  16.8  16.8  16.8  16.8  16.8  16.8  16.8  16.8  16.8  16.8  16.8  16.8  16.8  16.8  16.8  16.8  16.8  16.8  16.8  16.8  16.8  16.8  16.8  16.8  16.8  16.8  16.8  16.8  16.8
  19.5  19.5  19.5  19.5  19.5  19.5  19.5  19.5  19.5  19.5  19.5  19.5  19.5  19.5  19.5  19.5  19.5  19.5  19.5  19.5  19.5  19.5  19.5  19.5  19.5  19.5  19.5  19.5  19.5  19.5
  11.5  11.5  11.5  11.5  11.5  11.5  11.5  11.5  11.5  11.5  11.5  11.5  11.5  11.5  11.5  11.5  11.5  11.5  11.5  11.5  11.5  11.5  11.5  11.5  11.5  11.5  11.5  11.5  11.5  11.5
  11.7  11.7  11.7  11.7  11.7  11.7  11.7  11.7  11.7  11.7  11.7  11.7  11.7  11.7  11.7  11.7  11.7  11.7  11.7  11.7  11.7  11.7  11.7  11.7  11.7  11.7  11.7  11.7  11.7  11.7
   8.1   8.1   8.1   8.1   8.1   8.1   8.1   8.1   8.1   8.1   8.1   8.1   8.1   8.1   8.1   8.1   8.1   8.1   8.1   8.1   8.1   8.1   8.1   8.1   8.1   8.1   8.1   8.1   8.1   8.1
   0.5   0.5   0.5   0.5   0.5   0.5   0.5   0.5   0.5   0.5   0.5   0.5   0.5   0.5   0.5   0.5   0.5   0.5   0.5   0.5   0.5   0.5   0.5   0.5   0.5   0.5   0.5   0.5   0.5   0.5
   9.0   9.0   9.0   9.0   9.0   9.0   9.0   9.0   9.0   9.0   9.0   9.0   9.0   9.0   9.0   9.0   9.0   9.0   9.0   9.0   9.0   9.0   9.0   9.0   9.0   9.0   9.0   9.0   9.0   9.0
  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7  10.7
  12.2  12.2  12.2  12.2  12.2  12.2  12.2  12.2  12.2  12.2  12.2  12.2  12.2  12.2  12.2  12.2  12.2  12.2  12.2  12.2  12.2  12.2  12.2  12.2  12.2  12.2  12.2  12.2  12.2  12.2
   6.9   6.9   6.9   6.9   6.9   6.9   6.9   6.9   6.9   6.9   6.9   6.9   6.9   6.9   6.9   6.9   6.9   6.9   6.9   6.9   6.9   6.9   6.9   6.9   6.9   6.9   6.9   6.9   6.9   6.9
  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2  16.2
  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1  17.1
  12.1  12.1  12.1  12.1  12.1  12.1  12.1  12.1  12.1  12.1  12.1  12.1  12.1  12.1  12.1  12.1  12.1  12.1  12.1  12.1  12.1  12.1  12.1  12.1  12.1  12.1  12.1  12.1  12.1  12.1
  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7  17.7
   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
```

```
32 30 ROW_ORDER header ", chl_CET
  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0
  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0
  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0
  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0
  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0
  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0
  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0
  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0
  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0
  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0
  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0
  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0
  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0
  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0
  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0
  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0
  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0
  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0
  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0
  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0
  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0
  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6
  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0
  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0
  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0
  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0
  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0
  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0
  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6  10.6
  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0
  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0  11.0
  -1.0  -1.0  -1.0  -1.0  -1.0  -1.0  -1.0  -1.0  -1.0  -1.0  -1.0  -1.0  -1.0  -1.0  -1.0  -1.0  -1.0  -1.0  -1.0  -1.0  -1.0  -1.0  -1.0  -1.0  -1.0  -1.0  -1.0  -1.0  -1.0  -1.0
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APPENDIX C

Derivation of the Optimal Tariff in the Multisector Model

The Optimal Markup as a Function of the Elasticity

In our multisector, multiregion model, Chile will face an elasticity of demand for its exports that will vary with the sector and the region to which it exports. Suppose for any sector i, Chile faces an elasticity of demand $\in_{ir}$ for its exports to region R that is less than infinite. As long as this elasticity is less than infinite, Chile will possess some monopoly power on its exports. This monopoly power will be very small for high elasticities, but it will give rise to a positive optimal export tax.

Given a less than infinite $\in_{ir}$ Chile will maximize the profits from its exports of products in sector i to region R by setting marginal revenue equal to marginal costs. Then Chile must charge the price P_{ir}, where

$$P_{ir}\left[1-(1/\in_{ir})\right]=MC_{i.}. \qquad (1)$$

We have defined the elasticity to be positive in (1) and assume that $\in_{ir}$ is greater than one. As long as the elasticity is less than infinite, the optimum price exceeds marginal costs. Individual competitive firms will price according to marginal costs, so there is an optimal export tax to charge competitive firms so that they demand P_{ir} for their products. Inverting (1) to solve for the optimal export tax t^{*}_{ir}, we have:

$$P_{ir}=MC_{i.}/\left[1-(1/\in_{ir})\right]=MC_{i.}(1+t^{*}_{ir}) \qquad (2)$$

which implies that the optimal export tax is:

$$t^{*}_{ir}=\left[\in_{ir}/(\in_{ir}-1)\right]-1. \qquad (3)$$

where again $\in_{ir}$ is the elasticity of demand for Chilean exports from sector i in region R. The optimal export tariff varies inversely with the elasticity, but even for fairly high values like 21, the optimal export tax in a sector would be 5%.

From Lerner symmetry effects, Chile can exploit its monopoly power by employing an import tariff. If there were only one import and export good and only one export region, the import tariff could substitute perfectly for the export tax. But the import tariff will impose a more or less uniform export tax. Thus, it will not be a perfect

substitute for export taxes, because the import tariff will impose taxes on exports that will not vary across sectors and export markets with the elasticities of demand. Nonetheless, without export taxes, it will be optimal to have an import tariff approximately given by a weighted average of the optimal export taxes across sectors and regions. It remains to calculate this elasticity $\in_{ir}$ in our model.

The Utility Function Structure

In order to calculate the elasticity of demand $\in_{ir}$, it is necessary to derive the demand functions for Chilean exports in each of the products and export regions for Chile in our model. For each region r in our model, there is a representative consumer with a weakly separable utility function:

$$U_r = U_r\,(A_{1r},...,A_{24}) \qquad r = 1,...,11 \qquad (4)$$

where the goods A_{ir} i = 1,...,24 in our model, represent "Armington" aggregate goods . In general, we take this "top level" utility function to be of the Cobb-Douglas type, which implies that expenditure shares on each aggregate good are unchanged by changes in prices. For the purpose of this calculation, we assume that the demand for the Armingtom aggregate arising from other sources (intermediate demand, government and investment demand) has the same structure.

In order to improve the clarity, in what follows we suppress both sector and regional subscripts except where additional subscripts are required. The representative consumer in each region regards each Armington aggregate good A_{ir} as a CES aggregate of imports and domestically produced goods:

$$A = \overline{A}\left[\phi\, M^{\rho} + (1-\phi)\, D^{\rho}\right]^{1/\rho} \qquad \rho < 1 \qquad\qquad \sigma = \frac{1}{1-\rho} \;=\; \sigma_{D\,M} \qquad (5)$$

where σ_{DM} is the elasticity of substitution between aggregate imports and domestic production discussed in the text.

Similarly, the representative consumer in region r regards imports as an aggregate of imports from all the other 10 regions in the model:

$$M = \overline{M}\left[\sum_{r'=1}^{10} \psi_{r'}\; M_{r'r}^{\rho_M}\right]^{\frac{1}{\rho_M}} \qquad \rho_M < 1, \qquad\qquad \sigma_{mm} = \frac{1}{1-\rho_M} \qquad (6)$$

where $M_{r'r}$ = exports from region r' to region r in sector i.

and σ_{mm} is the elasticity of substitution between imports from different sources discussed in the text.

Since we are searching for the demand for Chilean exports, before deriving the demand functions, it is convenient to rewrite the subutility function for aggregate imports in the following equivalent form:

$$C = \overline{C}\left[\lambda\, C^{\rho_M} + (1-\lambda) R^{\rho_M}\right]^{\frac{1}{\rho_M}} \tag{7}$$

and

$$R = \overline{R}\left[\sum_{\substack{r'=1 \\ r' \neq Chile}}^{9} \theta_{r'}\, M_{r'r}^{\rho_M}\right]^{\frac{1}{\rho_M}} \tag{8}$$

Equation (6) is equivalent to the last two equations because we have the same elasticity of substitution in all equations.

The Demand Functions

Since this "nested" structure of utility functions implies that the utility functions are weakly separable, and the subutility functions are homothetic, the conditions which permit us to perform multi-stage budgeting are satisfied. Maximizing (5) subject to income allocation to the Armington aggregate yields the demand in region *r* for aggregate imports in sector *i*:

$$M = \overline{A}^{\sigma-1}\, \phi^{\sigma}\left(\frac{PM}{PA}\right)^{-\sigma} A \tag{9}$$

Similarly, maximizing (7) subject to the income allocated to aggregate imports, yields region r's demand for Chilean imports:

$$C = \overline{C}^{\sigma_{mm}-1} \lambda^{\sigma_{mm}} \left[\frac{PC}{PM}\right]^{-\sigma_{MM}} M \tag{10}$$

and where PA is the dual price of the Armington aggregate A, i.e., the price of a unit of utility of the Armingtom aggregate when purchased at minimum cost given prices PD and PM, and PM is the analogous dual price of the aggregate imports M, i.e.,

$$PA = \overline{A}^{-1}\left[\phi^{\sigma} PM^{1-\sigma} + (1-\phi)^{\sigma} PD^{1-\sigma}\right]^{\frac{1}{1-\sigma}} \tag{11}$$

$$PM = \overline{C}^{-1}\left[\lambda^{\sigma_{mm}} PC^{1-\sigma_{mm}} + (1-\lambda)^{\sigma_{mm}} PR^{1-\sigma_{mm}}\right]^{\frac{1}{1-\sigma_{mm}}} \tag{12}$$

and PC is the price of Chilean imports of sector *i* in region *r*.

Substituting for aggregate imports into the demand for Chilean products and rearranging, we have

$$C = K\left[\frac{PC}{PM}\right]^{-\sigma_{MM}}\left[\frac{PM}{PA}\right]^{-\sigma} A \tag{13}$$

where $K = \overline{A}^{\sigma-1}\,\overline{C}^{\sigma_{mm}-1}\,\phi^{\sigma}\,\lambda^{\sigma_{mm}}$ is a parameter that is constant.

The Elasticity of Demand

To obtain the elasticity of demand rewrite C from (13) as

$$C = H\left[PC, PM, PA, A; \Re\right] \tag{14}$$

where $\Re$ are the parameters of (13). Totally differentiating and using the chain rule, we have:

$$\frac{\partial C}{\partial PC} = \frac{\partial H}{\partial PC} + \frac{\partial H}{\partial PM}\,\frac{\partial PM}{\partial PC} + \frac{\partial H}{\partial PA}\,\frac{\partial PA}{\partial PM}\,\frac{\partial PM}{\partial PC} + \frac{\partial H}{\partial A}\,\frac{\partial A}{\partial PA}\,\frac{\partial PA}{\partial PM}\,\frac{\partial PM}{\partial PC} \tag{15}$$

Partially differentiating (13) we obtain:

$$\frac{\partial H}{\partial PC} = -\sigma_{mm}\left(\frac{C}{PC}\right)$$

$$\frac{\partial H}{\partial PM} = \left(\sigma_{mm}-\sigma\right)\frac{C}{PM}$$

$$\frac{\partial H}{\partial PA} = \sigma\frac{C}{PA} \qquad \textit{and} \qquad \frac{\partial H}{\partial A} = \frac{C}{A}$$

Using the expressions for PA and PM above, we have:

$$\frac{\partial PA}{\partial PM} = \overline{A}^{\sigma-1}\phi^{\sigma}\left(\frac{PA}{PM}\right)^{\sigma}$$

and $$\frac{\partial PA}{\partial PC} = \overline{C}^{\sigma-1}\lambda^{\sigma_{mm}}\left(\frac{PM}{PC}\right)^{\sigma_{mm}}$$

Finally, since the top level utility function is Cobb-Douglas,

$$A_i = \frac{s_i Y}{PA_i} \tag{16}$$

where s_i is the Cobb-Douglas share and Y is aggregate income at the top level.

Then

$$\frac{\partial A}{\partial PA} = \frac{-A}{PA}$$

Substitute in these partial derivatives into (15) and multiply both sides by $\frac{PC}{C}$ to obtain the elasticity. Simplifying we obtain:

$$\in = \frac{-PC}{C}\frac{\partial C}{\partial PC} = \sigma_{mm} - \lambda^{\sigma_{mm}}\left\{\left(\sigma_{mm}\right)\left(\frac{PM}{PC}\right)^{\sigma_{mm}-1}\overline{C}^{\sigma-1} + \left(\sigma-1\right)\phi^{\sigma}\left(\frac{PA}{PM}\right)^{\sigma}\left(\frac{PM}{PC}\right)^{\sigma_{mm}}\frac{PC}{PA}\overline{A}^{\sigma-1}\overline{C}^{\sigma-1}\right\} \tag{17}$$

First note that the term in brackets on the right side of (17) is multiplied by $\lambda^{\sigma_{mm}}$ where λ is approximated by Chile's share of the import market of sector *i* in region *r*.

Since this is likely to be small, the second term will be small relative to σ_{mm}. Thus, the first term on the right σ_{mm} dominates the elasticity. Secondly, since $\sigma_{mm} > \sigma$ and $\sigma > 1$, the second term on the right is positive. Thus, $\in -\sigma_{mm} < 0$, and the elasticity of demand for Chile's exports of sector *i* goods in region *r* will be less than σ_{mm}. Since it follows from (3) that the optimal tariff increases as the elasticity decreases, if Chile's market share is significant in some region for some product, the elasticity of demand is smaller and Chile's optimal export tax is higher.

The Optimal Tariff in Our Model

In our high elasticity scenarios, we have chosen σ_{mm} = 30 for all regions and products; and in the low elasticity scenarios, we have σ_{mm} = 8. Thus, when the Chilean share of the import market is small, from equation (3), the optimal tariff on Chilean exports of product i to regions r will be about 3.5% in the high elasticity case and about 14.2% in the low elasticity case. But, with either high or low elasticities, it will increase in those export markets where the Chilean share is significant.